COLLEGE OF ENGINEERING CORNELL UNIVERSITY



# the Cornell engineer


FEBRUARY 1957
VOL. 22, NO. 5
25 CENTS

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# Editorial . . .

This issue of the CORNELL ENGINEER is our annual issue directed to the high school seniors who are considering entering Cornell's College of Engineering. Our staff has felt for several years that high school seniors and their parents have a need for contact with Cornell students as well as the registrar and other administrative personnel. We hope this issue, written and edited entirely by Cornell students about Cornell and things of interest to Cornellians, will help provide this contact.

The article on Unistrut will be of particular interest to high school seniors in that it shows the type of projects carried out by students in the Colleges of Engineering and Architecture. This particular project was featured by the College of Architecture last year in the annual Engineer's Day. All the E-Day exhibits are built, operated, and coordinated by students of each school of the College of Engineering in a spirit of competition among the schools. E-Day is held in the hope of acquainting Ithacans, Cornellians, and prospective Cornellians and their parents with the work and facilities of the College of Engineering. We certainly hope some of our readers will be able to come to Cornell this year on May 3 for Engineers Day. We would like you to see our new engineering buildings, too.

The article on the history of Cornell's College of Engineering and the picture story about the new engineering campus show the steady progress our College has always made in improving facilities and equipment. Dr. Hans Bethe, a famous scientist and Nobel prize winner is featured this month in our faculty profile section.

Cornell has a lot to offer its students: an excellent engineering curriculum, brand new facilities, great numbers and variety of liberal courses to broaden our education, and extracurricular activities to interest everyone. We'll be looking forward to seeing you next fall.




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Founded 1885

THE CORNELL

# engineer

FEBRUARY 1957 VOLUME 22 NO. 5

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**COVER: Unistrut Tower used in 1956 Engineer's Day Exhibit at Cornell. See article on page 33.**

Published monthly—October to May—by the CORNELL ENGINEER, Inc., Lincoln Hall, Ithaca, N. Y. Edited by the undergraduates of the College of Engineering, Cornell University. Entered as second class matter at the Post Office at Ithaca, N. Y., under Section 103, Act of October 3, 1917.

Subscription per year: regular $2.00; with membership in the Cornell Society of Engineers $3.00; student $1.50; single copy $.25.

# HISTORY OF ENGINEERING AT CORNELL

by

David S. Lermond, ChemE '57

At the formal opening of Cornell in 1868 the only permanent building, Morrill Hall, was barely completed; the library was in a single room; the chemistry laboratory was a small room in the cellar of Morrill Hall, and the whole technical department was housed in a temporary shed. In spite of these crude facilities, President White and Ezra Cornell were determined to "found an institution where any person can find instruction in any study" and so Cornell became the first school in the country to offer both courses in engineering and liberal arts.

In 1868, civil engineering was fairly well established as a profession but mechanical engineering was still more an art than a science. Electrical and chemical engineering were unknown. The first announcement of the University listed a College of Mathematics and Engineering (consisting of a School of Mathematics and a School of Civil Engineering) and a College of Mechanic Arts.

The first Professor of civil engineering was William Charles Cleveland. Professor Cleveland was a graduate of the Laurence Scientific School and a scholar accomplished in several areas of science. He aimed to make his department the best of its kind. He insisted on holding the standard of scholarship high, maintaining that this was the only policy that would give it permanent success.

It was more difficult to establish the College of Mechanic Arts than the School of Civil Engineering. What actually constituted mechanic arts was still open to question.

← Sibley Hall.

Ezra Cornell wished to establish, in connection with the University, great factories for the production of articles for sale, especially chairs and shoes, thus giving large bodies of students opportunities for self support. It was only by the argument of President White that manufacturing and teaching would not mix that he was persuaded to give up the idea.

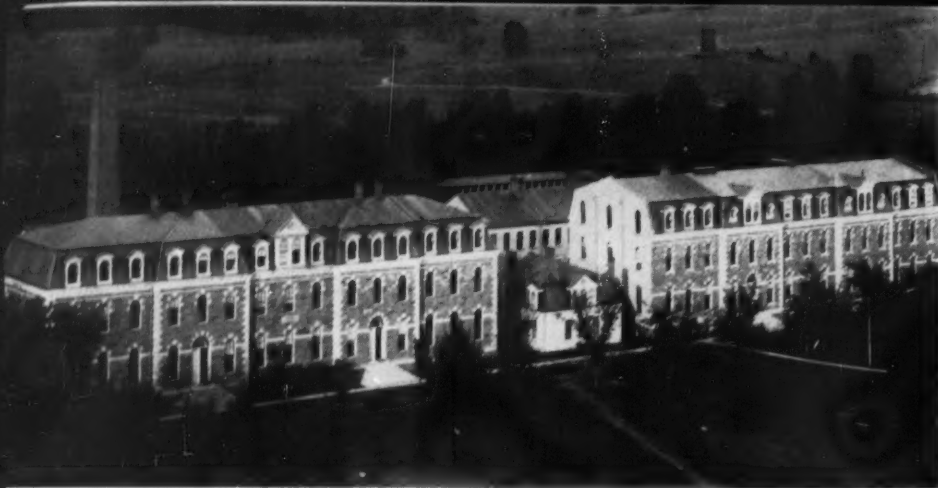
Provision for the College of Mechanic Arts was made by the appointment of John L. Morris, a graduate of Union College, as professor of practical mechanics and director of the shops. However, no provision for the College's equipment was made until after the opening of the university. There were no shops, laboratories, drafting rooms, or machinery to prepare for successful work in mechanical lines. Lectures and classes were held in a single room in Morrill Hall. A few years later the College of Mechanic Arts was moved to the newly finished chemical laboratory and was there housed until it became the nucleus for the development of Sibley College.

Sibley College of Mechanical Engineering dates from the year 1870 when Hiram Sibley, the first president of the Western Union Telegraph Company and a good friend of Ezra Cornell, began a series of contributions to the University which resulted in the erection of the building now known as West Sibley. After Mr. Sibley's death, his son, Hiram W. Sibley, gave East Sibley and Sibley Dome which were completed in 1894 and 1901.

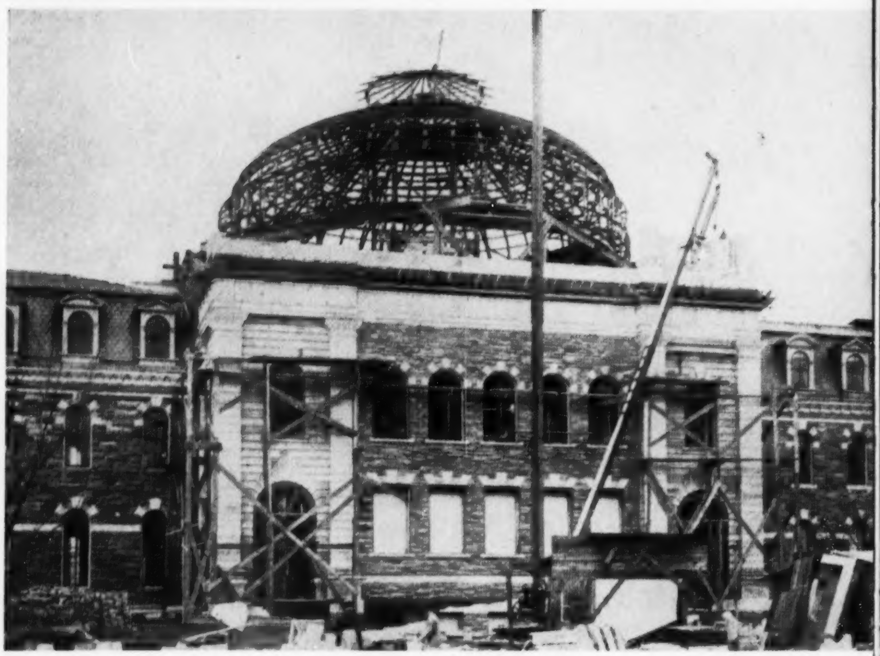
The Register for 1871 listed the College of Civil Engineering and Architecture, the College of Mathematics, and the Sibley College of Mechanic Arts. The name of the Reverend Charles Babcock now appeared as professor of architecture. Professor Babcock later designed the Old Armory, Sage College, Sage Chapel, and Franklin and Lincoln Halls.

Professor Cleveland died in 1873. Soon after his death, Professor Estevan Antonio Fuertes, a graduate of the Conciliar College of San Ildefonso, Spain, and of the Troy Polytechnic Institute, was called to be his successor as Director of the College of Civil Engineering. Professor Fuertes was a literary as well as a scientific scholar. He had been the engineer in charge of the Nicaragua canal survey for the United States and had wide experience as a consulting engineer in New York. He was the first of an interesting and distinguished group of teachers who made civil engineering at Cornell famous. In 1875 Charles Lee Crandall was appointed as assistant professor. Two years later I. P. Church was added to the faculty. Professor Church was an excellent teacher. His book on mechanics was a landmark in engineering textbooks. Through this book and the many teachers he trained, Church exerted a great influence on engineering education and his work did much to attract attention to the College. Henry S. Jacoby joined the faculty in 1890. His books on structural engineering, like Church's *Mechanics*, added greatly to the College's reputation.

As the College of Civil Engineering expanded, the plain wooden building known as the Chemical Laboratory was gradually vacated and the entire building was devoted to civil engineering.



East and West Sibley before the construction of Sibley Dome. West Sibley was given by Hiram Sibley, first president of the Western Union Telegraph Company. East Sibley was given by his son, Hiram W. Sibley.



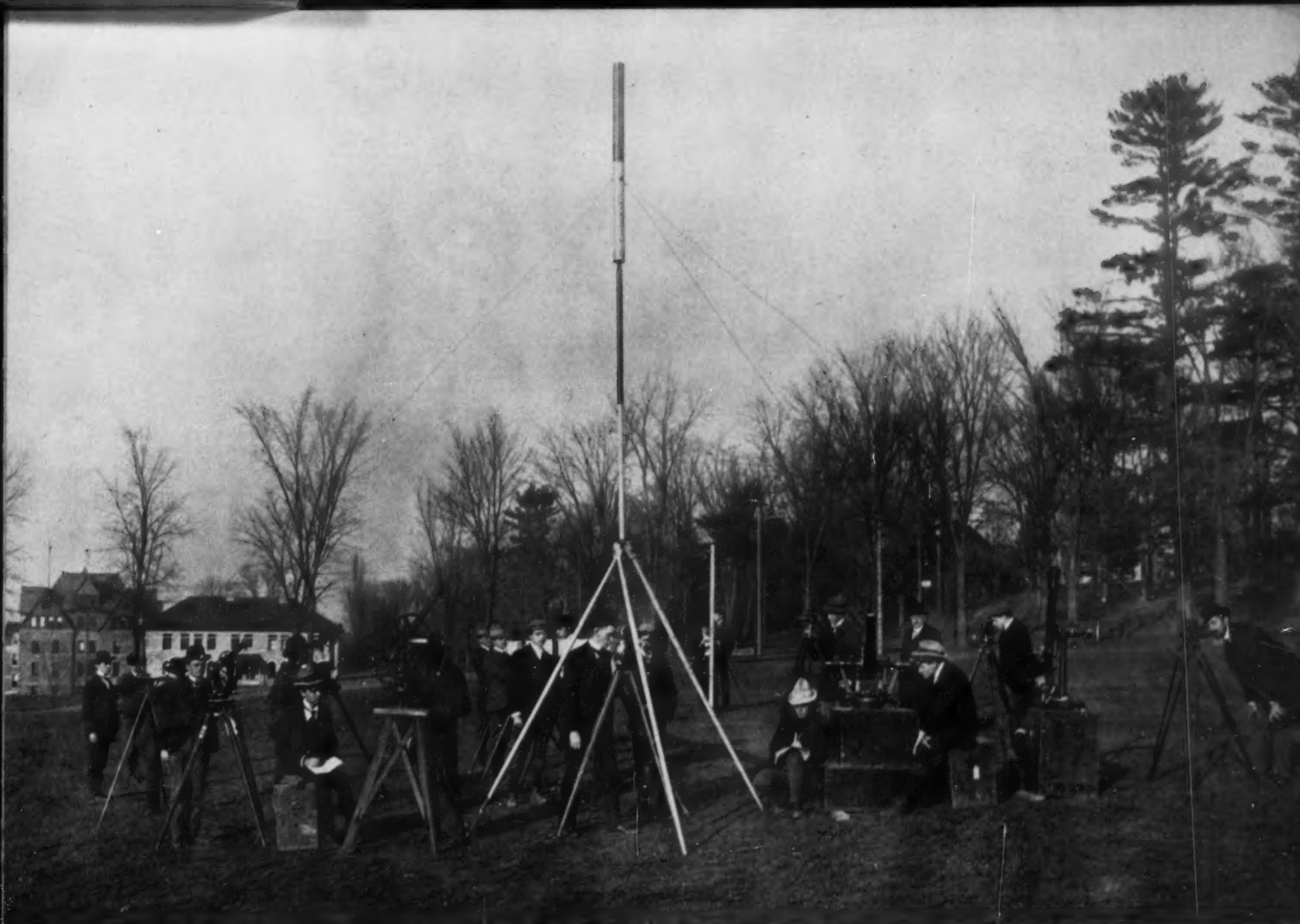
The construction of Sibley Dome in 1901 between East and West Sibley. The Dome was the gift of Hiram W. Sibley who also gave East Sibley and many of the shops.

Professor Fuertes as head of the College improved and added to the curriculum and over a number of years found it feasible to increase the entrance requirements. In this way he introduced more advanced topics into the civil engineering course. An example is in the teaching of surveying. Professor Fuertes believed that much of the field work in surveying could be better done in the field than on the campus. He therefore inaugurated a survey of the lakes of Central New York, beginning at Cayuga in the spring of 1874. This was, at the time, an untried plan but Professor Fuertes lived to see its adoption by practically every engineering school in the country.

In 1889, the College of Civil Engineering moved from the old wooden building into its new quarters in Lincoln Hall. In November, 1902, Professor Fuertes was forced to resign from active work because of ill health, and he died in January 1903. He had seen the department of 1873 with only one professor develop under his leadership into a college with a faculty of eight professors and eight instructors. As a memorial to Professor Fuertes, the Fuertes Memorial Speaking Contest is held each year in the College of Engineering.

In 1873, John E. Sweet was appointed master mechanic and director of the machine shop in Sibley College. He left in 1879, but while at Cornell, he did much to influence the College and the teaching of machine design. He was the first to recognize that the machine shop in connection with a technical school should primarily teach principles of construction and not handicraft. His Straight-Line steam engine was one of the significant products of the time.

In 1885, President White brought Robert Henry Thurston from Stevens Institute of Technology to be Director of Sibley College as part of a complete reorganization of the institution so that it would constitute a complete college of mechanical engineering and mechanic arts. This marked the beginning of a new era for Sibley College and for mechanical engineering in this country. President White later wrote, "Few days in the history of Cornell University have been so fraught with good as that on which Thurston accepted my call to the headship of Sibley College. At the very outset he gained the confidence and gratitude of the trustees, professors, students, and, indeed, of his profession throughout the country, by his amazing success as professor, as author, and as organizer and administrator of that department, which he made not only



Civil engineering students surveying on the quad about 1900. Lincoln Hall is in the background at the far left. Goldwin-Smith Hall had not been built. Professor Fuertes is standing in the background toward the right.

The campus about 1885. Sibley College is in the background at the right.

**The wood shop in Sibley College about 1875. Cornell was the first college to establish shops in connection with its School of Engineering.**

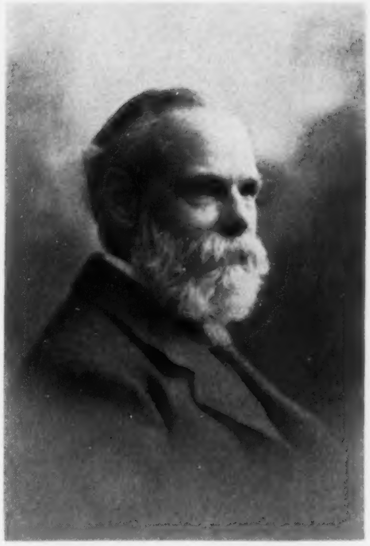
one of the largest but one of the best of its kind in the world."

A graduate of Brown University, Professor Thurston had seen service in the Navy during the Civil War, had taught five years at the Naval Academy, and at the time he was called to Cornell, was professor of mechanical engineering at Stevens. While there, he started a mechanical laboratory to give students actual experience in analyzing the characteristics of power machinery and other mechanisms. This was one of the first laboratories of its kind, and he brought the idea with him to Cornell. Thurston was a man of vision, a scholar, a writer, and one of the best-known engineers and engineering educators of his time. He was the first president of the American Society of Mechanical Engineers. His influence on research and graduate study and his many contributions to the literature of engineering and many other topics were largely instrumental in establishing the great reputation of Sibley College.

When Thurston came, the faculty consisted of two men besides Professor Morris. Thurston immediately began to augment this faculty with strong men; the most important among these was Dexter S. Kimball who later became the first Dean when the present College of Engineering was organized. Professor Kimball worked in machine shops until he was 28 when he decided to pursue higher education. In 1904, he began teaching what was probably the first administrative engineering course in this country. He taught this course until 1915, when he and two other professors formed the School of Industrial Engineering.

Under the leadership of Professor Thurston with men like Professor Kimball, Sibley College became concerned with subjects other than just the "mechanical arts" of drawing, drafting, and rudimentary construction, and engineering as we know it today grew up. Ten years after Thurston took charge, the entrance requirements were pushed up until they were the highest that had ever been required for any undergraduate course in this country. During Dr. Thurston's regime from 1885 until his untimely death in 1904, Sibley College grew from 150 to 1050 students in spite of the increasing requirements.

President White, in visiting the



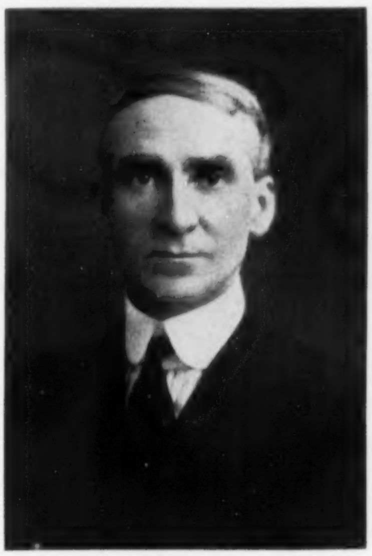
**Robert Henry Thurston, Director of Sibley College from 1885-1903. Under his leadership Sibley College rose to be one of the best engineering schools in the world.**

laboratories of Sibley College, noticed that many students were concerned with problems involving electricity. There had already been built in the machine shops, a dynamo which was used for lighting the campus, this being one of the first examples of outdoor electric lighting in the United States. Beginning in 1882, electrical engineering had been offered as a special option in the senior year, administered by the physics department. Now President White became interested in the formation of a department of electrical engineering. In order to insure its creation, he even promised to pay any extra expense caused by it during the first year. Dr. Thurston brought Professor E. P. Roberts to Cornell to head the first department of electrical engineering ever known in the United States. Professor Roberts stayed at Cornell only a year but electrical engineering was taken over by Professor Harris J. Ryan who became head of the department of electrical engineering in Sibley College.

In 1920 the various colleges were split into separate schools under one College of Engineering. Professor Kimball became Dean of the College, which included the School of Civil Engineering, the Sibley School of Mechanical Engineering, and the newly created School of Electrical Engineering.

Professor Kimball served as Dean of the College until 1936 when he retired. He did much to further the reputation of Cornell engineering by writing eight texts, among these his famous *Principles of Industrial Engineering*, and over three hundred papers and articles. He was national president of the American Society of Mechanical Engineers in 1921 and 1922, president of the American Engineering Council and vice-president of the Federated American Engineering Societies. He died at the age of 87 in 1952. The materials testing laboratory, Kimball-Thurston Hall, is named for him and Professor Thurston.

When Cornell was founded, chemical engineering as such was completely unknown. In the United States, chemical plants had been in operation since colonial

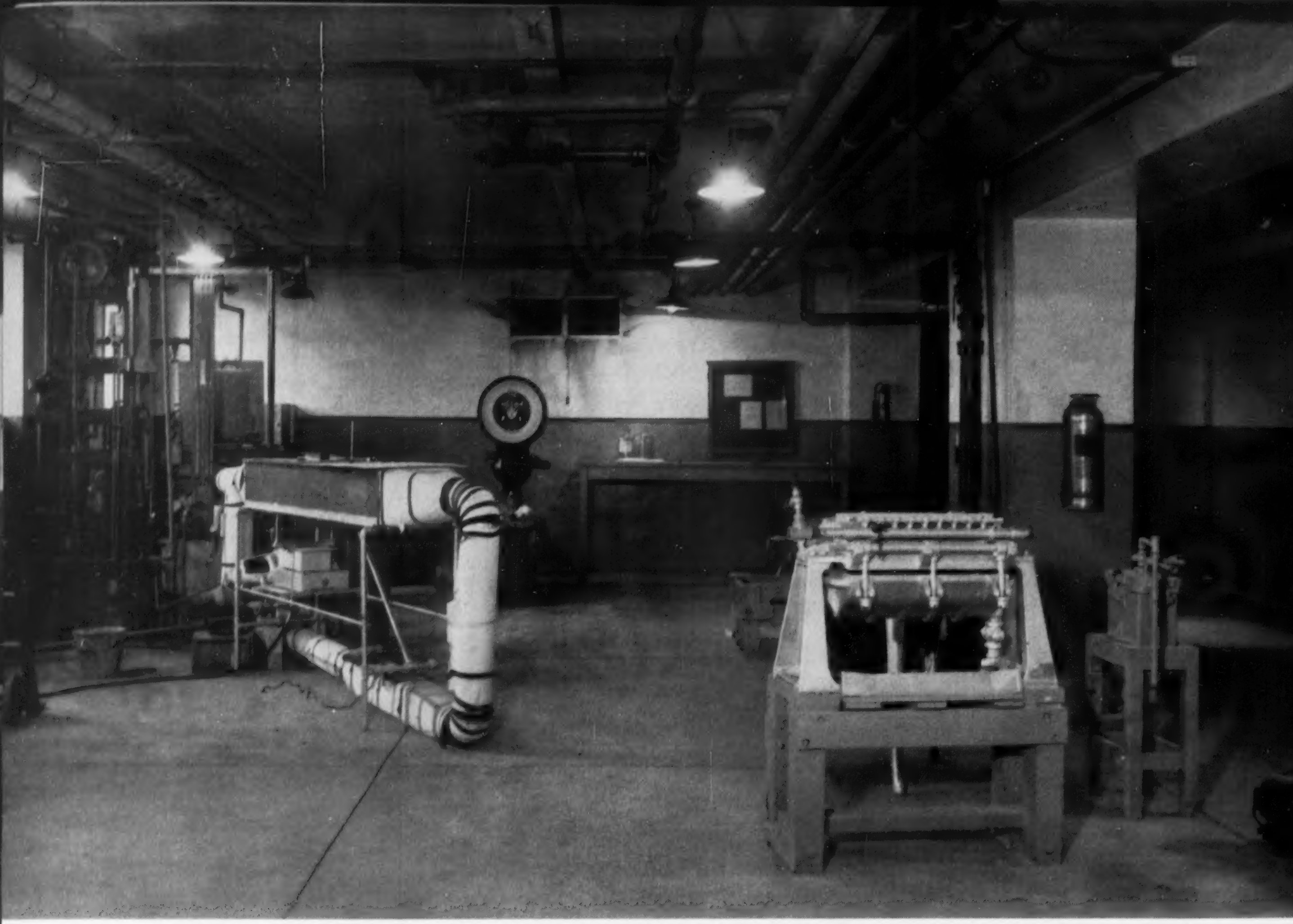


**Dexter S. Kimball, first Dean of the College of Engineering. Professor Kimball taught what was probably the first administrative engineering course in this country.**

times, but before the first world war there were very few. The United States was forced to enter the chemical industry when her supply of chemicals from Germany was cut off during the war. No separate degree in chemistry or chemical engineering was offered at Cornell before 1910. In that year the degree of Bachelor of Chemistry was offered in the newly organized College of Arts and Sciences. In 1916 the first course in industrial chemistry was given by F. H. Rhodes, then an instructor in the department of chemistry and now Director of the School of Chemical and Metallurgical Engineering. The name "chemical engineering" for the course was avoided because of objections of some of the members of the staff of the chemistry department. In 1920 Professor Rhodes became professor of industrial chemistry and gave courses in "Industrial Chemistry Lectures" and "Industrial Chemistry Laboratory." These courses covered the field of what is now known as the unit operations of chemical engineering. They became "Chemical Engineering 705" and "Chemical Engineering 710." Although now given under the title Chemical Engineering 5353 and 5354, "710 lab" is still noted for its long reports and the grading system which was developed by Professor Rhodes.

In 1931 a five-year course leading to the degree of Bachelor of Chemical Engineering was offered with students receiving the degree of Bachelor of Chemistry after the completion of four years' work. The course was supervised by a committee composed of Professor Rhodes, Professors Diederichs and Davis of the School of Mechanical Engineering and Professors Papish and Mason of the chemistry department. In 1938 the School of Chemical Engineering was formed as one of the four schools in the College of Engineering. Professor

**Estevan Antonio Fuertes, Director of the College of Civil Engineering from 1873-1902. Under his leadership the department of 1873 with only one professor, developed into a college with a faculty of eight professors and eight instructors.**



**The chemical engineering unit operations laboratory in the basement of Baker Laboratory of Chemistry. The School of Chemical Engineering was housed in Baker until the completion of Olin Hall in 1942.**

Mason transferred to the new school along with Professor Rhodes. The degree of Bachelor of Chemistry was discontinued and a five-year course in chemical engineering was offered. The faculty of the school was enlarged, and in 1942 it was moved from the basement of Baker Laboratory to its present home in Olin Hall.

Cornell's chemical engineering school is now ranked as one of the very best in the country. Its success is due largely to the efforts of Professor Rhodes to improve the School and maintain its high standards. Professor Rhodes plans to retire in June of this year but his influence on chemical engineering at Cornell will be felt for many years to come.

During the summer of 1946, the Board of Trustees of Cornell established the most recent addition to the College of Engineering—the Department of Engineering Physics. The objective of the new curriculum was to provide a type of training which combined the basic scientific background and analytical training of the physicist with the methods and knowledge of the engineer.

The Department of Engineering Physics was developed because of the continued growth of industrial research organizations and the increased need of special training for research work. The department was aimed to provide this special training.

The new department is administratively placed within the College of Engineering but it is operated through the close cooperation of both the College of Engineering and the College of Arts and Sciences. The faculty of the department is composed of members from both colleges. However a few belong directly to the Department of Engineering Physics.

Dr. Lloyd P. Smith was first director of the department. Dr. Smith left July 1 to become vice-president of the Avco Manufacturing Company. The present Acting Director is Trevor R. Cuykendall.

The present high standing of Cornell's College of Engineering is the result of the combined efforts of many men. Only a few of the early leaders in each engineering school have been mentioned. The present faculty is now engaged in continuing the work of these early pioneers—that of making Cornell's College of Engineering one of the finest in the country.

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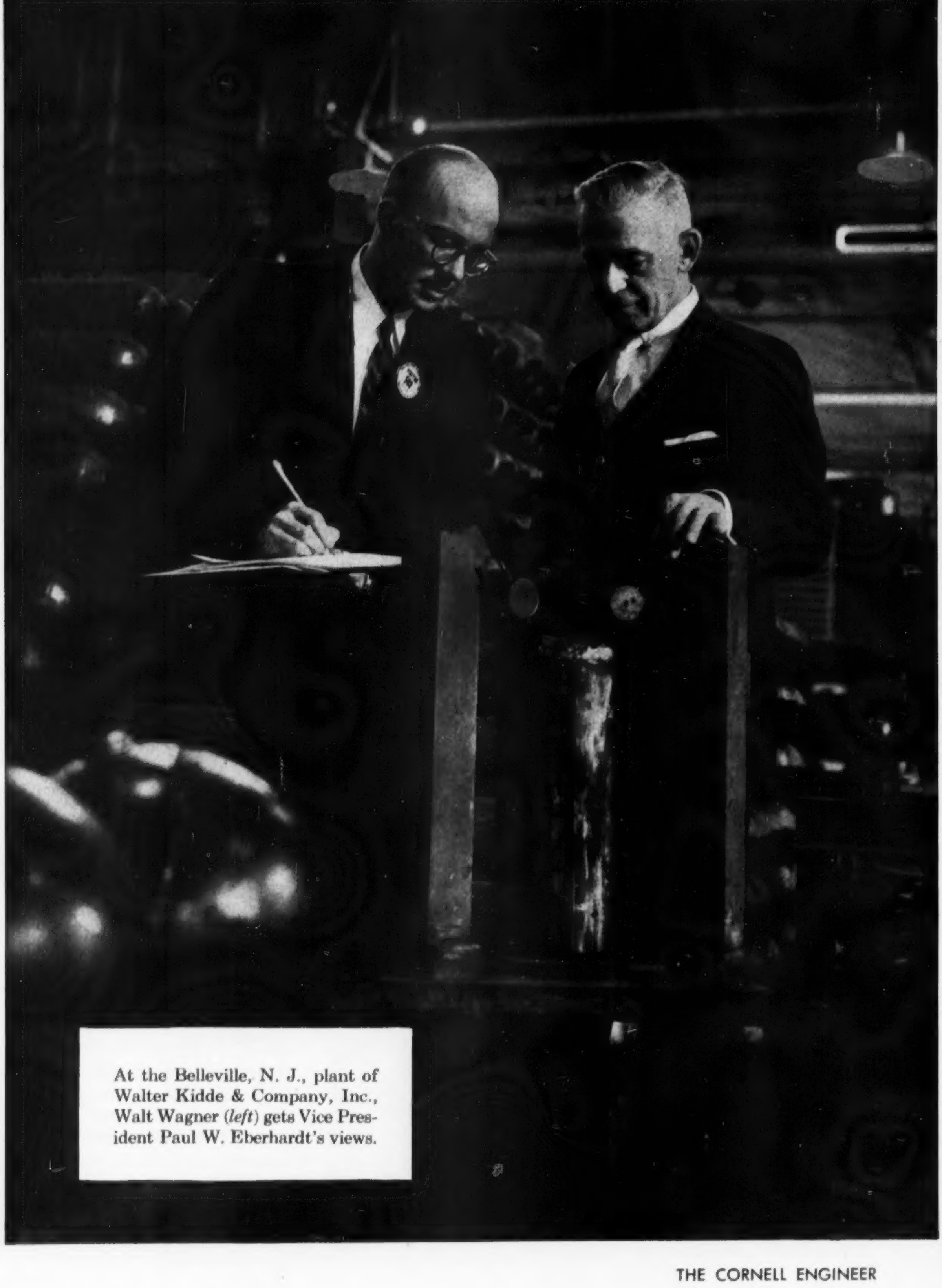

At the Belleville, N. J., plant of Walter Kidde & Company, Inc., Walt Wagner (*left*) gets Vice President Paul W. Eberhardt's views.

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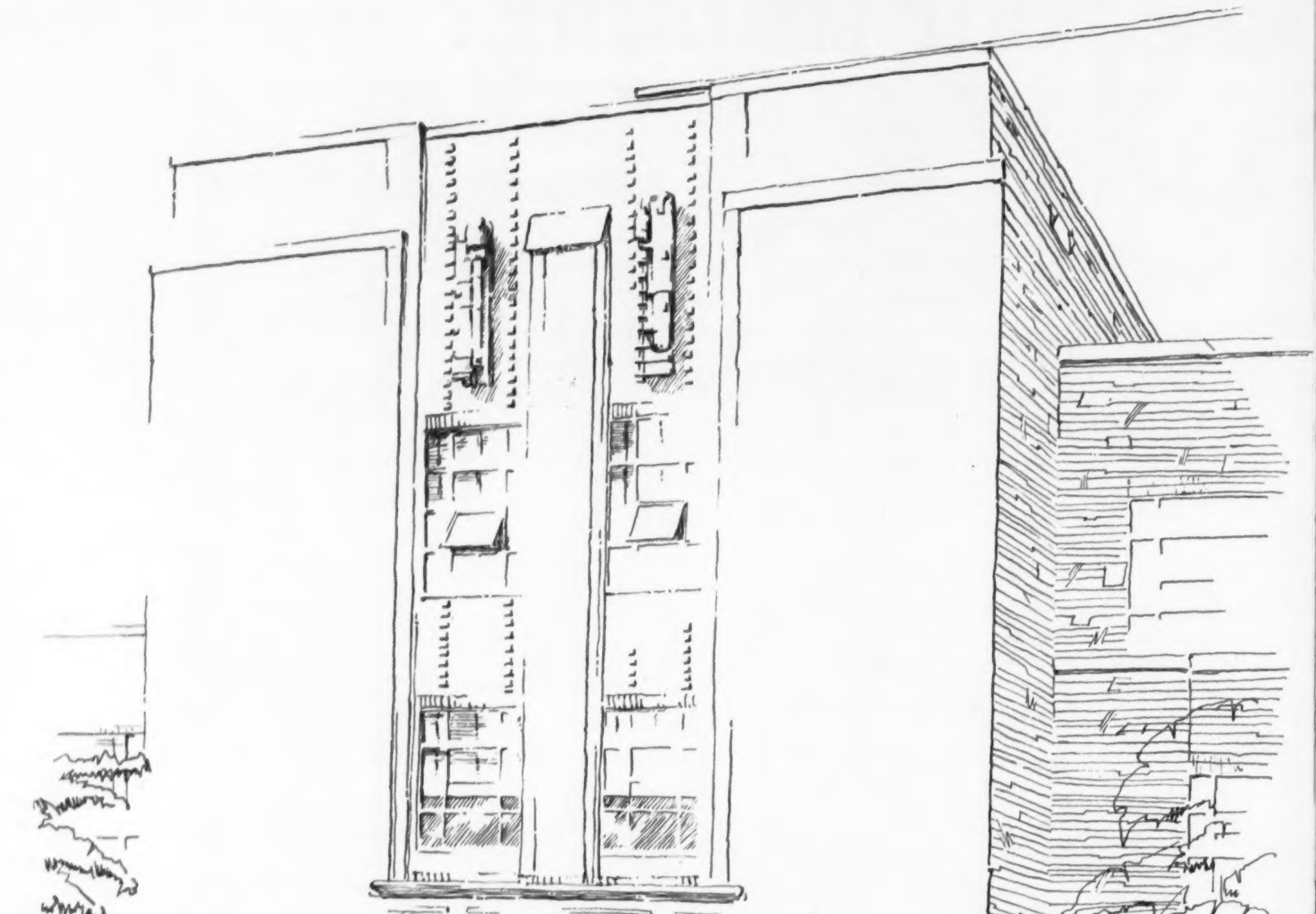
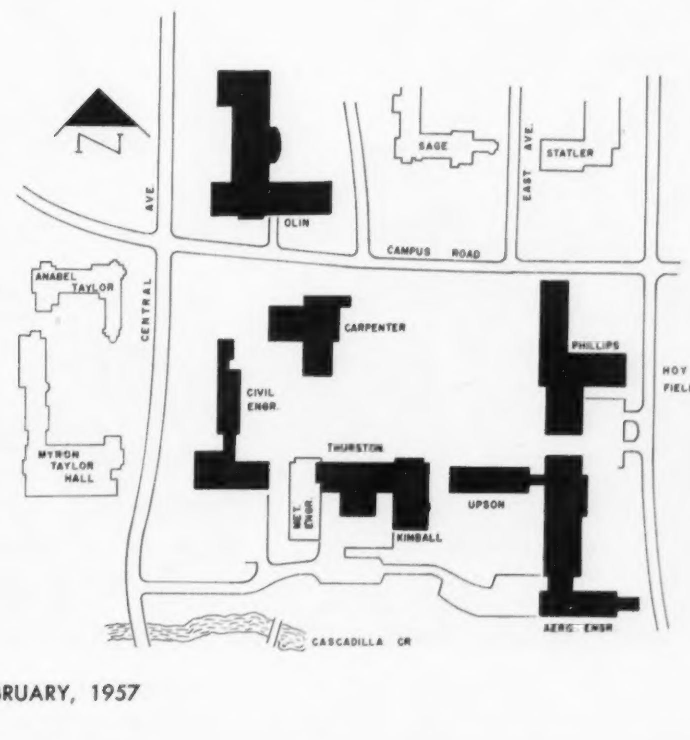


**Olin Hall, housing the School of Chemical Engineering, was completed in 1942, the first step in building a new engineering quad.**

# ENGINEERING QUADRANGLE NEARS COMPLETION

by
Alan Rosenthal, EE '60

Cornell University will soon be able to claim that its engineering school is among the most modern and complete in the country. By 1959 eight buildings will comprise an impressive engineering quadrangle at the south end of the campus. Culminating more than forty years of hoping, planning and working by thousands of interested alumni and friends, the quadrangle will replace buildings that have served the College of Engineering since the early days of the University.




### Early Building Plans

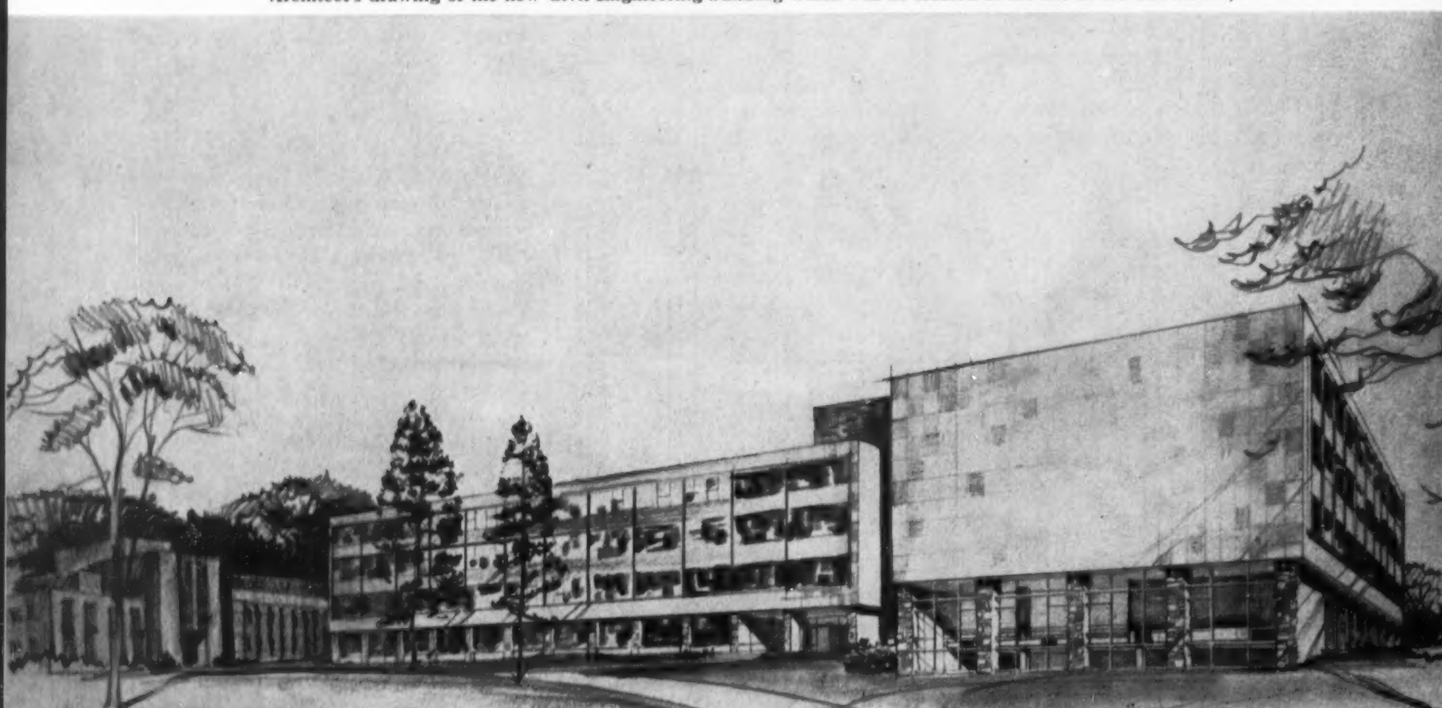
In 1912 Dean Kimball, then head of the Mechanical Engineering school, proposed planning for the remodeling of the engineering buildings. Various schemes were studied and several preliminary steps were taken in the next 25 years. In 1937, when S. C. Hollister became Dean of the College of Engineering, plans for the present completely new engineering quadrangle began to develop.

The earliest plans to renovate the engineering buildings were based on the idea of using the area now occupied by Sibley, Lincoln, Franklin and Rand Halls. The possibility of tearing these buildings down and constructing a separate engineering quadrangle at the northeast end of the main quadrangle was considered.

**Map of the proposed engineering quadrangle with those buildings completed or planned for completion by 1959 shown in black.**

Upson Hall, future home of the Mechanical Engineering School, and largest of the new additions.

Architect's drawing of the new Civil Engineering building which will be located at the site of the Old Armory.



An even earlier program, designed to expand laboratory space in the engineering school was based on the idea of using Sibley Hall but tearing down the laboratories behind it. These structures were to be replaced by several buildings similar in design to Rand Hall.

One of the most striking early designs to increase the engineering college's facilities was the plan for a huge eight-story structure to occupy the entire north end of the quadrangle to the edge of the gorge. This plan envisioned the entire engineering school housed in one building.

Plans for the present engineering quadrangle were begun by Dean Hollister. Now, twenty years since his first plans were made, the new quadrangle is being completed. It is hoped that the entire "quad" will be finished by 1959, before Dean Hollister's retirement.

#### Construction Begins

The first building in the present plan was started in 1941. Completed in 1942, this building now houses the School of Chemical and Metallurgical Engineering. Donated by Franklin W. Olin, the structure provides excellent and enlarged facilities for instruction and research in these fields.

World War II made further building for the engineering college almost impossible. Moreover, war inflation jeopardized all plans. Original cost estimates were completely out of range, and plans had to be revised. After the war, efforts were made to economize on many of the features of the new structures. The administration at one point considered the possibility of building only one wing of a building at a time, with the hope that added funds would eventually make it possible to complete the structure. Fortunately the generous assistance of Cornell benefactors made it possible to proceed with each new building as a complete unit.

Despite these difficulties, Kimball and Thurston Halls were completed in 1951. Built as a memorial to two early leaders of the College, the structure was the gift of a large number of engineering alumni. The unique feature of Thurston Hall is, of course, its huge testing bay.

Kimball and Thurston Halls replaced Rand Hall. They provide the College with extensive laboratories, recitation rooms, and lecture rooms for the study of engineering materials and materials processing. It is planned that some time in the near future a wing will be added to the west side of Thurston Hall. This wing is to hold the Metallurgical Engineering Department, now housed in Olin Hall and in the foundry behind Sibley. At present it seems that this structure will be the last one on the engineering quadrangle to be completed.

The fourth unit to be constructed was Phillips Hall. The School of Electrical Engineering previously had been housed in five separate buildings. The new Electrical Engineering building, given by the Ellis L. Phillips Foundation, in honor of Mr. Phillips, Class of 1895, served to consolidate the school as well as to provide it with new and enlarged facilities.

Phillips Hall has an unusually large proportion of laboratories and project rooms. It was designed in this way so that it would provide ample space for graduate and fifth-year projects, and for faculty research. The laboratories were made to be flexible; they can now be used for many different projects rather than for one or two permanent ones.

The present building program which began early last year will bring the quadrangle nearly to completion. The only portion remaining unfinished will be the Metallurgical Engineering wing of Kimball-Thurston Halls.

#### Carpenter Hall

The first building scheduled for completion is Carpenter Hall. The gift of Walter S. Carpenter Jr., Class of 1910, Carpenter Hall will serve as the library and administrative center of the Engineering College.

The greater part of the space in Carpenter Hall will be used for library purposes. There will be two large central reading rooms as well as an informal reading room. Books will be held in three-tier stacks in the northeast corner of the building.

The administrative offices of the Engineering College will be located on the second floor. A unique feature of the building will be the twelve research reading rooms on the second floor. These rooms will be for the exclusive use of persons doing specialized research reading in some field of engineering. Certain of these research rooms, however, serve a dual purpose. During the weeks when company representatives come to campus to interview prospective employees, the rooms will provide the additional space needed for these meetings.

The contemporary exterior design of all the new buildings is planned to harmonize with the neighboring engineering buildings. The interior walls of Carpenter, as well as those of all the other buildings, will be cement block. Color treatment of interior walls is an important feature of the architectural design.

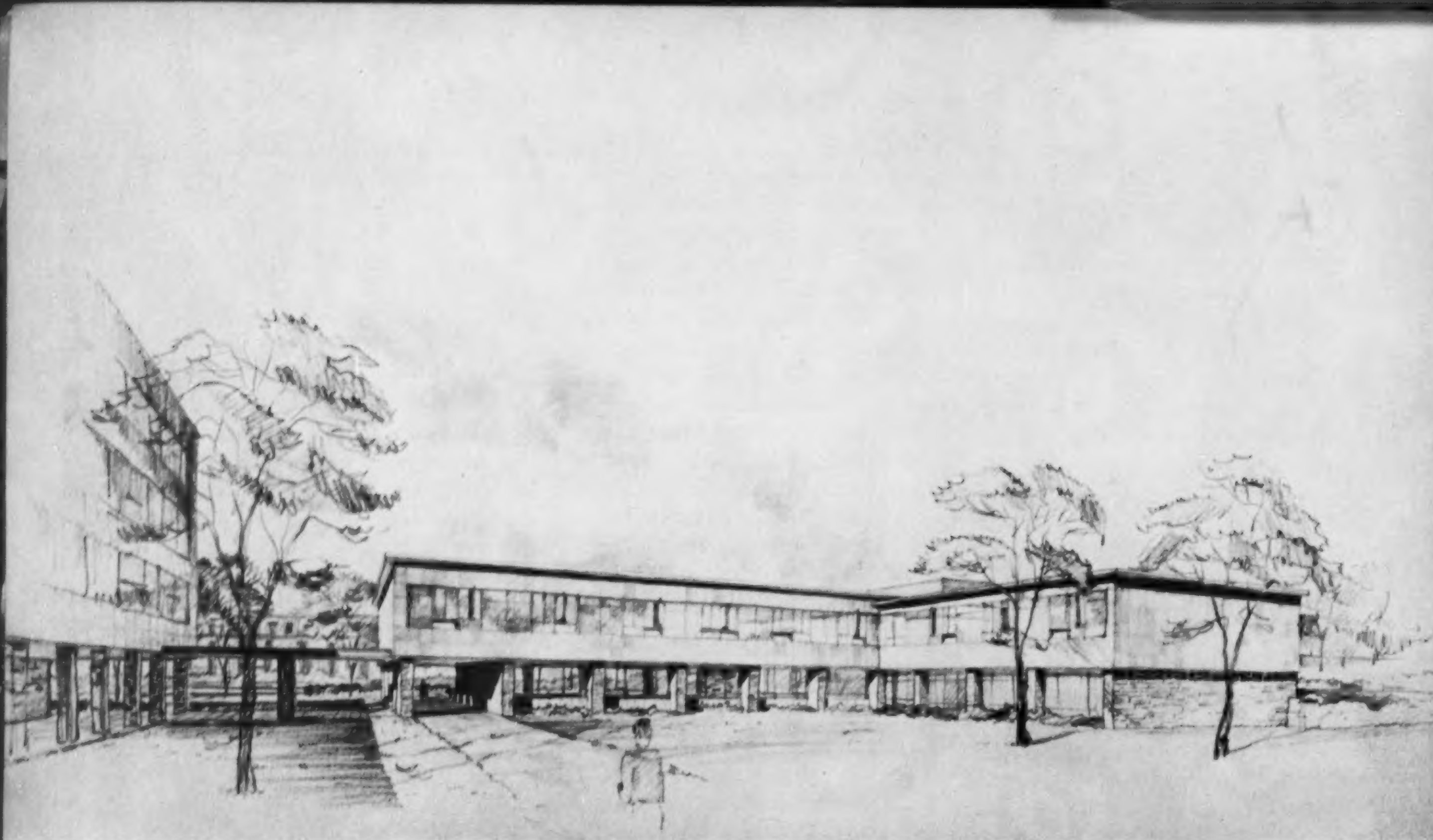
#### Upson Hall

Also under construction is Upson Hall, which will house Mechanical Engineering. It is the gift of Maxwell M. Upson, Class of 1899, and will be the largest of the nine units in the quadrangle.

Upson Hall has two wings at right angles to each other. The wing parallel to Phillips Hall is devoted to laboratories, while the other wing, next to Kimball Hall, provides classroom and administrative facilities for the Mechanical Engineering school.

The laboratory wing is designed so that each level has a central source of utilities. It will have four levels with certain pieces of equipment on the ground floor requiring two stories. All of the laboratories represent a major advance in this type of facility, with considerable potential for the future. Although the new laboratories now have their counterpart in Sibley or in one of

*(Continued on page 23)*



Carpenter Hall, scheduled for completion this spring, will contain administrative offices and the engineering library.

Kimball-Thurston Hall houses the Department of Engineering Mechanics and Materials along with its large testing area.

**Phillips Hall, location of the School of Electrical Engineering with many laboratories and project rooms for research.**

*(Continued from page 21)*

the annexes, many areas of work that have been cramped will have space and equipment to meet their needs. Among the laboratory facilities which will be available are those for internal combustion engines, turbo generators, temperature investigations, instrumentation and control, combustion research, engine component studies, methods and production engineering, gas turbines, and solar radiation and air flow studies. In this wing there will also be separate rooms for computation and research. A good portion of the open laboratory floor space will be devoted to graduate research and fifth-year projects.

The classroom and administrative wing of Upson Hall will have five levels; the laboratory wing, four, with provision for a fifth. The former will house a large lecture room and a student lounge as well as all Mechanical Engineering administrative offices and classrooms.

This wing, like the laboratory wing, is designed for maximum flexibility. Furniture will not be bolted to the floor; consequently, a classroom or recitation room can easily be converted into a lecture or conference room. Drawing rooms as well as other rooms are designed for greater utilization.

**Aeronautical Engineering Building**

Attached to Upson Hall's laboratory wing and at right angles to it will be the new Aeronautical Engineering building. The entire Mechanical-Aeronautical Engineering building combination will have a "Z" shape.

The Graduate School of Aeronautical Engineering has been housed in temporary quarters since its beginning in 1945. Growth of its activities has been rapid. The new building, the gift of an anonymous donor, will provide many of the facilities that are needed for the advancement of its work. This increase in facilities will make it possible for the school to handle approximately 90 students – three times the present capacity—as well as a wide range of research.

The building will have three levels, the first of which will be devoted entirely to laboratory work. It is on this floor that the two-story wind tunnel will be located. Located on the same floor is a room with various safety features built solely for the storage of hydrogen.

Located beneath the first floor is a high pressure source of air. This feature of the new structure will undoubtedly prove to be very valuable. A compressor and 200-cubic-foot tank will provide air at a pressure of 3000 pounds per square inch. This equipment is the only permanent apparatus being installed in the building. All of the other equipment is designed so that it can easily be removed or modified. Those involved in the designing of the building feel that a high

pressure source of air will always be necessary in aeronautical engineering work whereas wind tunnels and similar apparatus may become obsolete, or require modification for special work.

The second level of the Aeronautical Engineering building will have eight small laboratories as well as several large laboratory areas. One of these areas will serve as a cascade laboratory. On this floor and on the first are several darkrooms, essential to the large number of high speed experiments which can be observed only on film.

The third level of the building will hold all of the offices and classrooms. Lecture room, lounge and, to some extent, laboratory facilities will be shared by the Mechanical and Aeronautical Engineering schools. Since the work in the two schools is often interdependent, it is felt that these close physical relationships will be mutually beneficial to both departments. Needless to say, the sharing of facilities will also reduce the cost of the buildings.

The Aeronautical Engineering building, which stands at the southeast entrance to the engineering quadrangle will have a large, glass-enclosed lobby. The lobby and its exhibits will not only provide an impressive entrance to the engineering quadrangle, but will also be a distinctive entrance to the entire Cornell campus.

#### Civil Engineering Building

Ground will be broken for the eighth structure, the new Civil Engineering building, this spring. The gift of Spencer T. Olin, it will occupy the site upon which the Old Armory now stands. At present, the plans for the new building await final development.

The shape of the new structure will resemble that of a "T", the "leg" of the "T" lying across the street from Myron Taylor Hall. This wing of the building will, for the most part, hold all classrooms and offices. The other wing of the building, lying immediately behind the Kappa Alpha fraternity house, will contain most of the laboratory facilities.

When this building is completed, the entire Civil Engineering school, with the exception of the Hydraulics Laboratory, will be housed in one building. It is now housed in Lincoln Hall as well as in several of the temporary buildings. All of the laboratories now in use will be transferred to more spacious and efficient quarters in the special wing.

The completed building will have four floors. The main lecture room will be located in the classroom wing, and a two-story hydraulics laboratory will occupy part of the laboratory wing. The general offices, student lounge, and student activities center will be located on the second floor.

Space has been reserved for display cases with numerous exhibits to be located at central points on every floor, each exhibit to be handled by a different department in the Civil Engineering school. The plans also provide generous space for fifth-year work and graduate research.

#### Completion Predicted for 1959

With the completion of the Civil Engineering building, eight of the nine planned units on the engineering quadrangle will be finished. The only unit which will not be finished is the Metallurgical Engineering building to be added to the west side of Thurston Hall.

According to present building plans, Carpenter Hall will be finished in May of this year while Upson Hall should be completed in September. It is expected that the Civil Engineering building will be completed by September 1958. It has been necessary to postpone the construction of the Aeronautical Engineering building until the completion of Upson Hall; however, the plans are to have the building ready for use by 1959.

Movement of equipment into the new buildings will begin in May with the opening of Carpenter Hall. Equipment for both Carpenter and Upson Halls will be installed during the summer; however, it is expected that some of the equipment for Upson Hall will have to be installed after classes have begun. Much of the present equipment is in good condition and will be reused, but additional new equipment will also be installed.

#### Unusual Landscaping Planned

Careful plans have been made for the landscaping of the quadrangle, following removal of the School of Industrial and Labor Relations from its temporary buildings on this site. The engineering "quad" will be somewhat smaller than the main "quad," but despite the smaller area there is no question about the fact that the main "quad" is going to lose a good number of surveyors.

The engineering quadrangle may not be able to boast of a statue of "Ezra" and "Andy," but it will have some very distinctive landscaping. The difference in elevation between Phillips Hall and the Civil Engineering building will permit a terraced type of landscaping. Present plans call for different types of plantings on each terrace.

There will also be a large parking area. The parking lot behind Kimball-Thurston Halls will be enlarged and a new lot will be built behind Upson Hall.

When the new Metallurgical Engineering unit is completed, all of the main buildings of the College of Engineering will be consolidated at the south end of the campus. The High Voltage Laboratory, Radio Astronomy and Radio Wave Propagation Laboratories, the Ionosphere Laboratory, and the Hydraulics Laboratory will remain at their present locations for technical reasons. The Hydraulics Laboratory, the oldest in this group, ultimately will undergo major modernization. The entire laboratory will be completely remodeled, giving it full advantage of its unusual natural site adjacent to Triphammer Falls. The plans also call for the installation of facilities for channel flow studies.

By 1959 the engineering quadrangle will be substantially complete. It will represent the fruition of a dream—the dream of deans and faculty, of thousands of alumni, and of many friends of the school. Yet, the completion of the quadrangle will not really be the end of anything. Cornell University's new Engineering quadrangle is merely a stepping-stone—a stepping-stone to the future. With the unexcelled opportunities for developments in teaching and research made possible by this new plant, Cornell can be assured of the continuation of its long tradition of leadership in engineering education.

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# THE CO-OP PROGRAM AT CORNELL

by

Allan Ginsberg, ME '58

Today, many undergraduate engineering students find themselves faced with the questions of whether or not they should seek jobs in the engineering field during their vacations, and how they should go about obtaining jobs that will not only supply sufficient monetary returns, but also offer knowledge and experience that will be useful to them in their future careers.

The first of these questions will receive varied answers from different people, but the most valid answer will probably come from a student or an engineer who has had the opportunity to work in his field during his undergraduate studies. The answer in this case will invariably be that the experience has helped considerably in giving the student an opportunity to observe at close range the nature of the work of engineers, scientists, supervisory personnel, production leaders, sales personnel, and management, thus educating the student in many of the ways of engineering and industry that could not possibly be taught at any school. This opportunity, more often than not, is an invaluable aid to the aspiring engineer, in choosing the phase of engineering in which he plans to make his career.

The student engineer of today, because of the wide diversity of engineering fields and the trend toward specialization is, or should be, particularly aware of the problem of choosing a general area in which to concentrate his studies. This, of course, is impractical in many cases, without a first hand view of the areas available. Too many students, because of a lack of interest in any one field, will go through college, enter industry and then find they are hindered by a lack of training in the field in which they are engaged. This situation is, of course, one which colleges of today, by making their curriculums as broad and comprehensible as possible, are striving to avoid; but the more formal training a student can receive in the general area in which his future work will be, the greater his rate of professional growth is bound to be.

Obtaining an engineering job that will not only supply monetary rewards but, more important than that, will supplement the college education and give the student a comprehensive picture of industry, is often a problem of no small consequence. At Cornell and at a few other universities, such as Rensselaer Polytechnic Institute and the Massachusetts Institute of Technology, an important step in solving this problem has been taken—the institution of the Co-operative Engineering Education Program. Under this program, the student engineer accepts a job with an industrial firm and spends an average of twelve months during his college career working for this company. All phases of the program are closely supervised by the university program administrators.

Many students, after being informed of the Co-op Engineering Program, will ask why they should bother with this program when they can procure summer employment on their own with engineering firms adjacent to their homes. Justification for the Co-op Program comes partly from the fact that, during the summer months, industry is usually deluged with requests from college students for temporary employment, thus, rendering many of the jobs offered to the student narrow in scope and unchallenging to the inquisitive student. In addition, the constant supervision of the professor in charge of the Program makes it possible for the student, who is justly dissatisfied with an assignment, to do something about the cause of the dissatisfaction.

The unavailability of satisfactory summer jobs is reckoned with in the Co-op Program by allowing the student to perform his work in

A Co-op student putting theory into practice as he operates a complex machine which is typical of that employed by industry. He is thus acquiring practical experience which is essential for success in industry.

industry during three periods: one fall semester, one spring semester and one summer period. In order to make up the fall and spring terms missed on campus, the student spends two summers at Cornell in special Co-op sessions. Invariably, when the prospective Co-op student is informed of this phase of the Program, he voices many objections, such as: "I wouldn't want to spend a whole summer in school and, anyway, I'm engaged in an extra-curricular activity that I would have to give up if I left campus for a term."

The first of these objections is easily abated by any student who has spent a summer at Cornell. He will, undoubtedly, first mention the fact that, because of the small classes, the close association with the professors and instructors and the concentrated type of curriculum, he finds himself having very little trouble scholastically, and having a good deal of free time as well. He will then expound on the varied activities he participates in to use up this free time, ranging from swimming and golf with the boys, to participation in the various social events sponsored by the University and Mu Sigma Tau, the Co-operative Engineering Honorary. The ratio of about 3 to 1 or 4 to 1, *girls* to *boys*, considerably aids the latter time consumer.

For those students engaged in extra-curricular activities, which will not permit their absence for a term, special arrangements can and have been made to switch the work session to another time.

In the opinion of many, a big drawback to the elective Co-op Program is the fact that usually not all of those wishing to enter can be accepted but, if the present growing interest of industry in such programs continues, a much larger percentage of students and universities will enter co-operative programs. The present system of admission to the Program consists of interested students in their fourth term of study at Cornell being interviewed by the various participating companies. At present, there are nine companies working in conjunction with the Cornell Co-operative Program. They are the General Electric Company, International Business Machines Corporation, Philco Corporation, Air Reduction Company, Procter and Gamble Corporation, American Gas and Electric Service Corporation, Combustion Engineering Corporation, Cornell Aeronautical Laboratories, and Stromberg Carlson Company. At present, the Program is limited to mechanical and electrical engineers and a few engineering physicists, and selection of the students by the company is based on academic standing, as evidenced in the student's scholastic achievements, and personal characteristics as shown in the interview with the company representatives.

Co-op students pay the regular college tuition fee. While on industrial assignment, they receive compensation at the going rate. From their earnings they pay their expenses for subsistence and for travel to and from assignments, except in unusual cases. The student is asked to specify his choices for the location of these assignments in the cases where the company has more than one operating department, and the company usually attempts to comply with the student's choice.

Next, the prospective co-op engineer might well ask, "What are my obligations, or what are the company's obligations upon graduation?" In answer, he will find out that, upon completion of the program, both company and student are free agents. There is no commitment on the part of the Company to offer students permanent employment, nor is there any commitment on the part of the students to accept such employment, if offered. Naturally, it is hoped that the mutual experiences between company and student will have been so satisfactory as to lead to an offer and acceptance of employment. The primary objective of the program is long range in character and is one of training; financial aid to the student, although not to be discounted, is considered of secondary importance.

The varied nature of assignments is geared to technical training and to equipping the student to accept

responsibility, so important in engineering as well as in other fields of endeavor. Most of the assignments lie in the engineering or design area, but, depending on the student's individual preference, may be also in the manufacturing or production, and research or development fields. To insure a well-rounded training, successive co-op industrial assignments should include one of each of these types of activity. Thus, upon completion of the program, both company and student will have ascertained for which type of work the student is best adapted. Even though the student remains with one company for all of his assignments, the nature of most of the participating companies is such that he may receive experience in many varied fields. Examples of a few of the jobs held by Co-op Engineers may help to illustrate the variety and the scope of the training available through such a program. In the engineering or design phase, one student was assigned as the assistant to a product design engineer engaged in the mechanical design of radar and sonar systems for the government. His duties, at first, consisted mainly of assisting the engineer in the design and testing of this equipment, but after a short while he was given the responsibility of designing and building, on his own, various parts of the system under development. The supervision and advice of the senior engineer was continually available, but at no time was the student discouraged from individual creation. At the completion of his assignment, he saw many of his own designs incorporated into the finished equipment. An assignment in the research and development field, recently given to a sophomore electrical engineer, involved investigations in the new, fast-growing semi-conductor and transistor industry. Though the student had had no previous training or knowledge in this area, both he and the company reaped numerous benefits from this experience. Lastly, a junior mechanical engineer was assigned to the automation department of one of the largest television plants in the country. One of his tasks involved the planning of the color television assembly line of this concern. His work not only included the actual design and layout of the highly automated production line, but also included the supervision of its installation. It was in this latter capacity that the student had many dealings both with management and labor, and in working between the two, he acquired an experience in dealing with people that would be difficult to duplicate in school or in many of the jobs offered to students as summer employment. On the same assignment, the student was asked for ideas on the improvement of the high volume manufacturing process of a small electrical component. Working on his own, consulting literature, and actually conducting experiments, the student submitted an improved process, anticipating a net saving to the company of over $25,000 per year. These and many other examples illustrate the high character of Co-op assignments and, in addition, they point to the fact that these jobs are not just "created" to keep the students busy but, rather, are interesting, educational, and responsible tasks. This type of work is made available by the Co-op Program because of the staggered system of assignments, whereby the companies can depend on having a Co-op student to fill given jobs, twelve months of the year.

Acceptance of responsibility, training in varied fields of engineering, and dealing with people from top management to labor are some of the experiences a Co-op student enjoys at an early stage of his education. As a result of these integrated experiences and the full realization of the many facets of his progress, the average Co-operative graduate usually finds he is two or three years ahead of his classmate who has had no industrial experience.

Reference A.I.E.E. Conference Paper, "The Role of Elective Co-operative Programs in Modern Engineering Education," by S. B. Wiltse, E. M. Strong and E. W. Boehne.

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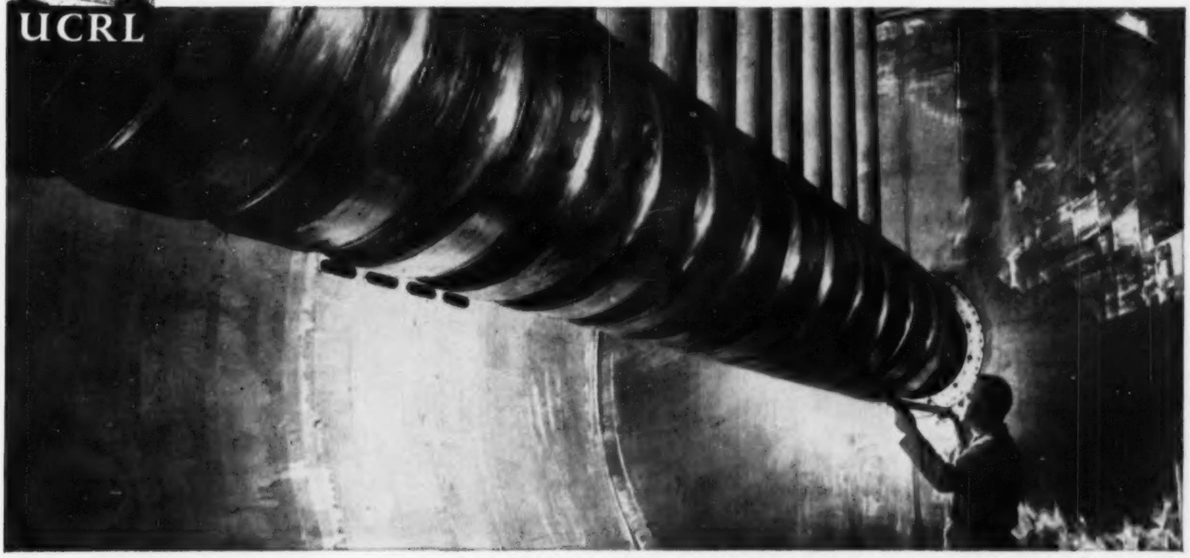

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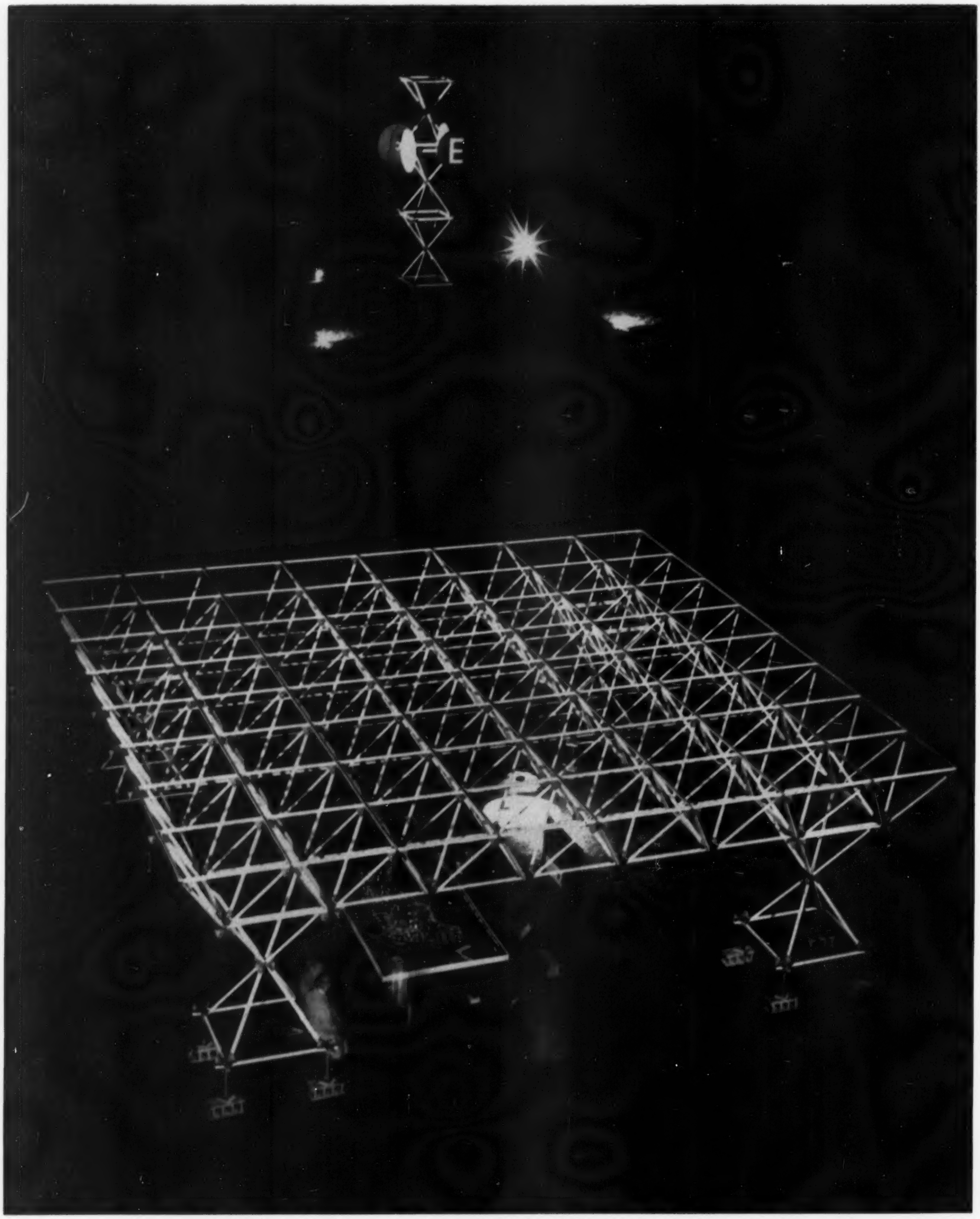


Cornell College of Architecture Pavilion on the quadrangle for 1956 Engineer's Day Exhibition.

# UNISTRUT

## SPACE FRAME CONSTRUCTION SYSTEM

by
Edward Rosen, Arch. '57

The Unistrut Construction System is perhaps the most complete manifestation of the contemporary economic situation in the building world. Its place in the architecture of today and tomorrow may be a significant one, due to the solution it proposes to the problem: Can the general public afford good architecture?

The history of architecture, since the age of the wattle and daub huts, has been profoundly influenced by the economic conditions of its changing times. "Economic" may be too sophisticated a term for the conditions that dictated the architecture of pre-historic man. Availability of materials and labor with which to turn these materials into shelter is more appropriate. Today the problem is essentially the same. Availability of material and labor and their comparative cost in our current means of exchange dictate the forms that our architecture takes.

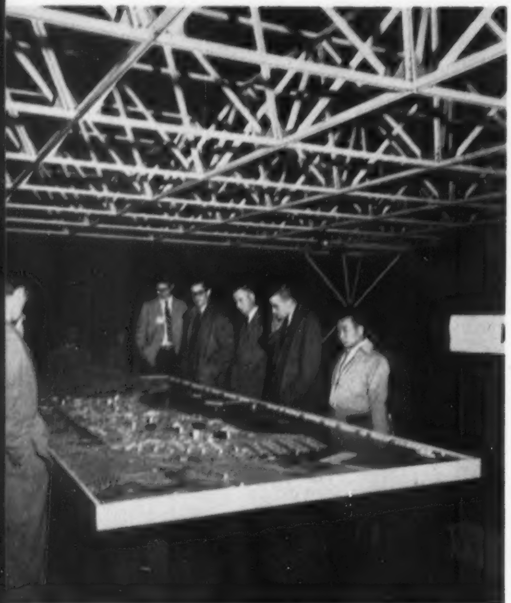
The colossal Egyptian, the elegant Grecian, the soaring Gothic and more recently the gleaming International Style were all manifestations of the needs of society and the means that were available to best provide for them.

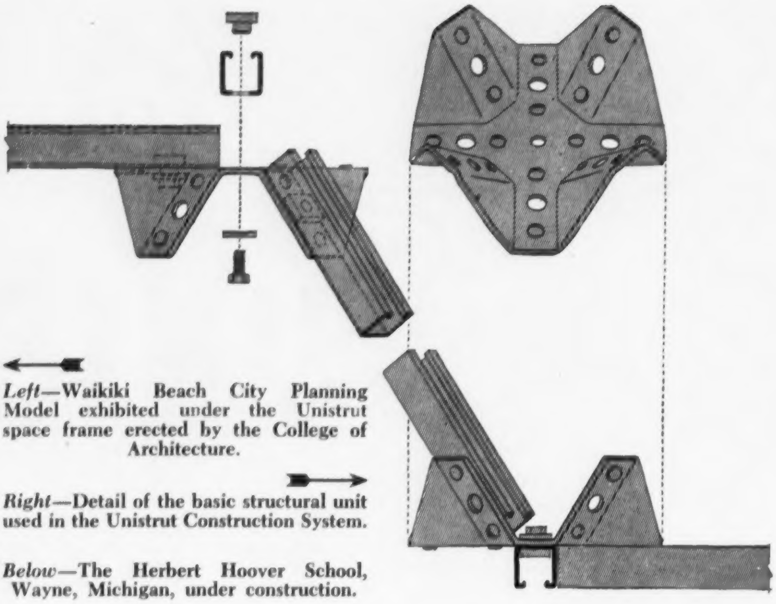
**BUILDING MARKET**

Current building market conditions are peculiar to our country and times. Although building materials are plentiful and generally inexpensive, rising labor costs are driving building costs skyward and many potential builders to cover.

Since on-the-job labor costs are the most significant factor in the rising building cost scale, American architects and builders have turned to industry for standardized and prefabricated building parts, in order to reduce on-the-job costs. Industry has responded with package curtain walls, floor systems, partitions, prefabricated window assemblies and even prefabricated homes, lift slab and tilt-up techniques.

Architectural Research Building, University of Michigan, Ann Arbor.





*Left*—**Waikiki Beach City Planning Model exhibited under the Unistrut space frame erected by the College of Architecture.**

*Right*—**Detail of the basic structural unit used in the Unistrut Construction System.**

*Below*—**The Herbert Hoover School, Wayne, Michigan, under construction.**

**DEVELOPMENT OF THE SYSTEM**

The Unistrut Space Frame System, developed and marketed by the Unistrut Corporation of Wayne, Michigan, and studied at the University of Michigan, is one of the latest, and perhaps the most advanced architectural product in this trend. It carries prefabrication, standardization and ease of assembly right to the heart of architecture, the structural system.

The product, a light steel channel, was originally conceived of as framing for industrial purposes, racks and partitions. Then, Charles Attwood, president of the Unistrut Corporation, experimented with the product for use as framing for his factory in Wayne, Michigan. This led him to approach the University of Michigan with a suggestion that a study of the method might come up with a workable school construction system. The College of Architecture and Design conducted a research program under the supervision of Professor C. Theodore Larson. The criteria set up for judgment of any of the proposed solutions are of considerable interest, for they serve to identify not only the goal of this research project, but more generally the aim of this current trend of standardization and prefabrication. They are:

a. the structure should be made of durable materials

b. it should be easy to erect, with no single part so heavy or so bulky that it could not be readily handled by one or at most, two workmen

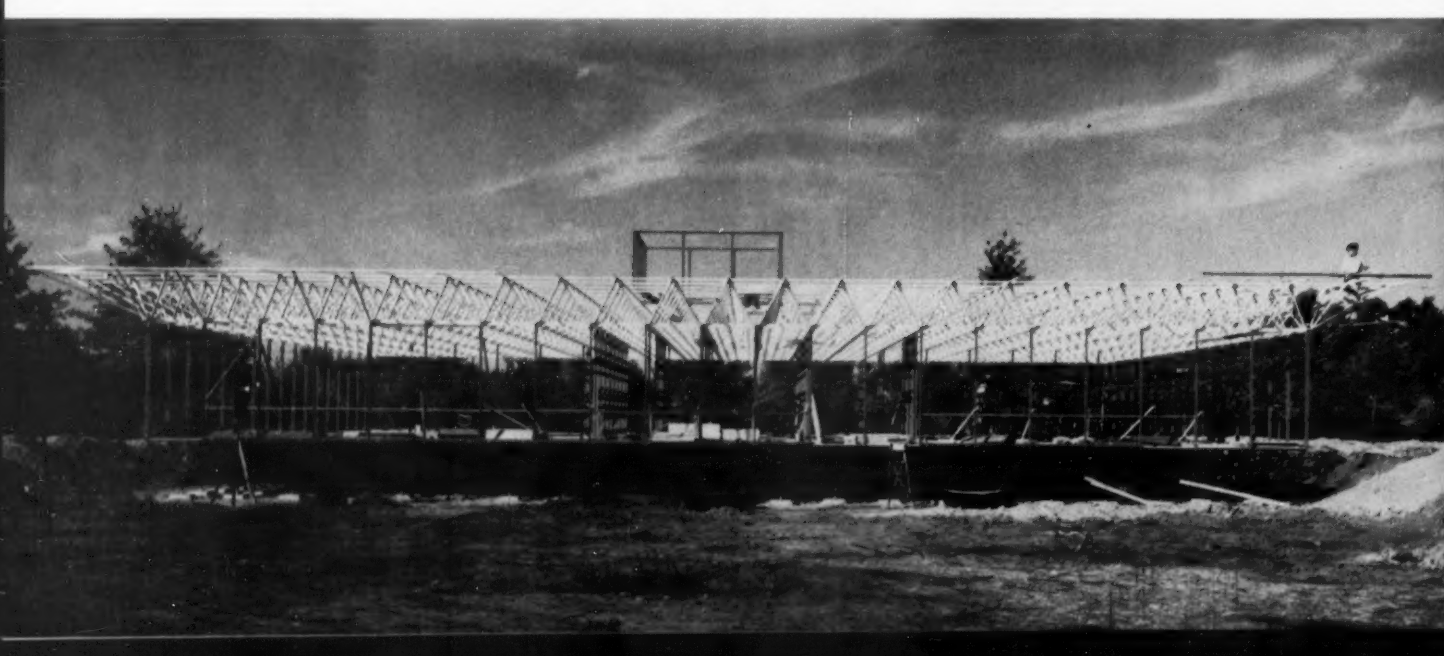
c. it should be capable of easy disassembly

d. it should be capable of easily being altered by addition or subtraction of space or by rearrangement of existing space

e. the parts should be reusable either in another building or for some other purpose

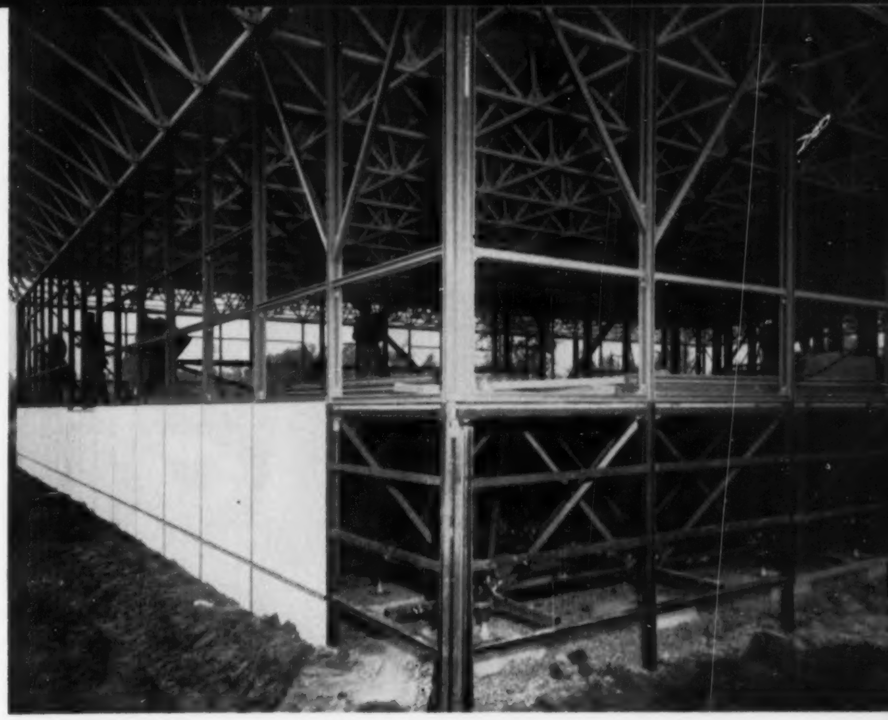
Except for the criteria concerning disassembly and reuse of parts these standards are also applicable to other standardized, prefabricated or simplified architectural systems.

What finally resulted from the study was a school construction system. This system, very completely studied, was published in a



*Right*—Construction detail of Herbert Hoover School construction.

*Below*—Herbert Hoover School, Wayne, Michigan, after completion.



pamphlet entitled *Unistrut School Construction.* But more significant than the school construction itself, this study pointed up rather severe limitations of the system and led to the second project which resulted in the Unistrut Space Frame System.

**SPACE FRAMES**

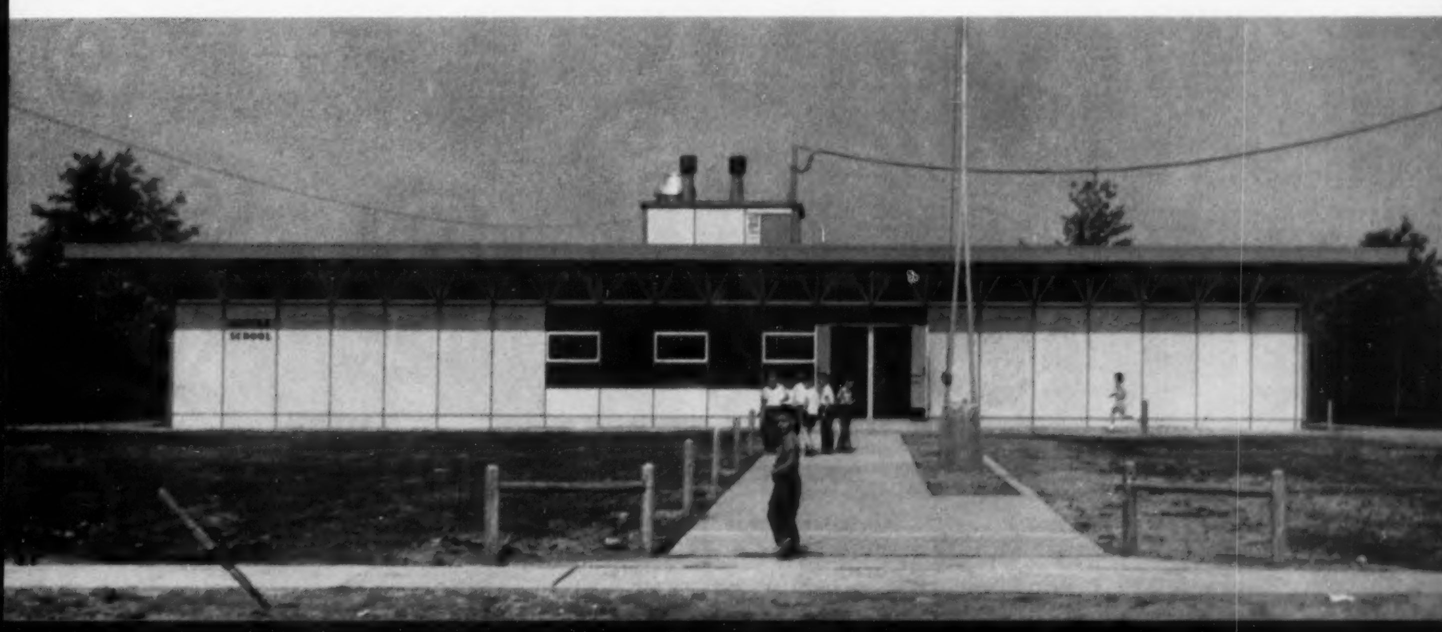
A space frame is a three-dimensional structural skeleton. The loads on it are resolved into components in the planes of the members. Due to its efficiency of stress resistance a space frame can be used over very long spans. The function of the building can be further divorced from the structure, yielding design freedom and flexibility.

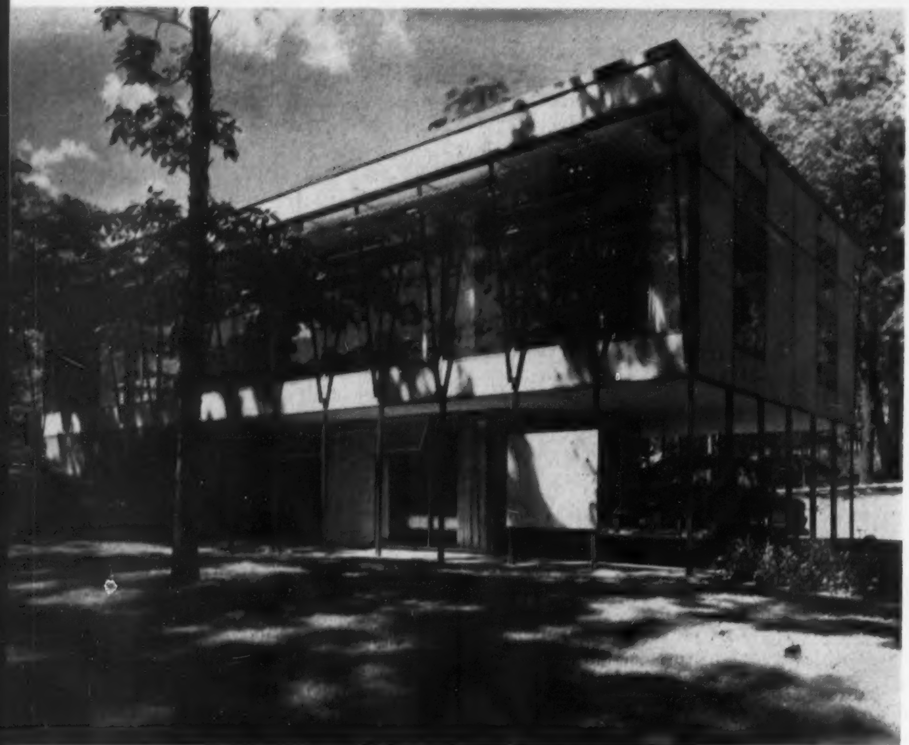
The space frame is not unique with Unistrut. Advanced work in conceptual and analytical space frame design has been contributed by Pier Luigi Nervi, Robert Blancanceaux, R. le Ricolais, Mark Hartland Thomas, Felix Samuely, Buckminster Fuller and Conrad Wachsman. In recent years space frames have become increasingly important in achieving amazing long span roofing feats. Great airplane hangars have been designed embodying the space frame principle.

In 1949, a space frame structure was designed using standard Unistrut Channels and 3-dimensional bolted connectors. Since such a structure was capable of carrying forces in three or more directions simultaneously, the supporting structure might be considerably more flexible, allowing for variation in size of the building. The second project, research into the space frame system, produced solutions to many of the practical problems.

**CONSTRUCTION**

What finally evolved from a period of design and testing was a standardized system of roof and floor construction using only three items, the Unistrut channel, the connector plate and the bolt assembly. The upper surface is fitted with asbestos cement panels. The members form the edges of alternating erect and inverted pentahedrons whose bases generate two parallel planes and whose sides create a series of tetrahedrons. For simplicity and economy, both of construction





and erection, all members are alike and assembled with identical connectors. The connectors are designed so that each member takes only two bolts, one at each end.

The roof structure can be supported by bearing walls, stud walls or columns anywhere beneath it, as long as the spans are not excessive. The system is designed on a 49″ grid and is expansible without limit. Unistrut stud walls, designed earlier as part of the school construction study, are made to take prefabricated wall panels, similar to the asbestos cement panels mentioned above. The 49″ module takes standard 4′-0″ sheets of building panels without trimming. The additional inch is accounted for by ⅞″ for the Unistrut channel and ⅛″ tolerance. Fiberglas insulation panels and acrylic plastic windows have been used in the existing schools and homes built with Unistrut. Sealer is needed for only a few of the joints.

**POTENTIAL USES**

The potential of this construction method is patently enormous. Through standardization of the depth of the space frame the scale of Unistrut spans has been limited, but this could be only temporary.

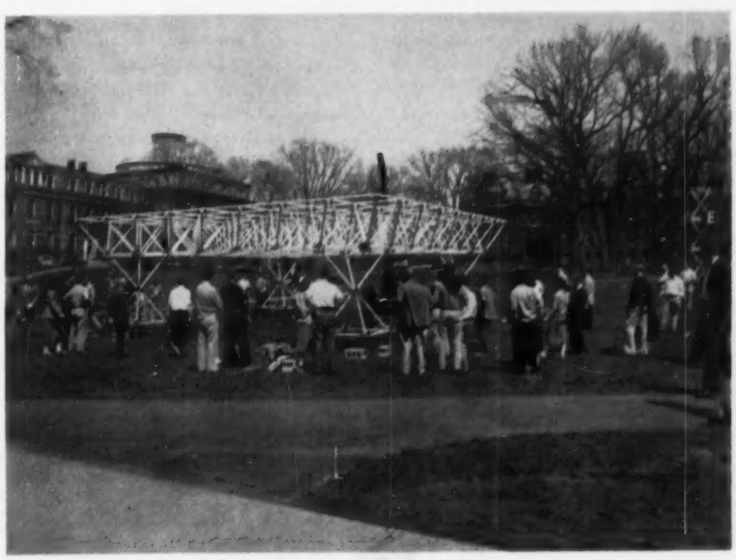
**Above and right are the houses of Professors Sanders and Larson, faculty members of the University of Michigan College of Architecture. Both men designed their own homes using the Unistrut Construction System.**

Longer, heavier gauge channels and connectors could be manufactured for longer spans without losing the inherent economy of the system. The standard Unistrut now produced is used for building types varying from schools to residences, factories to laboratories. Examples are an elementary school and factory in Wayne, Michigan, a laboratory building for the College of Architecture at the University of Michigan and the two handsome homes designed for themselves by Prof. Walter Sanders and Prof. C. Theodore Larson of the faculty of the College of Architecture and Design at the University of Michigan.

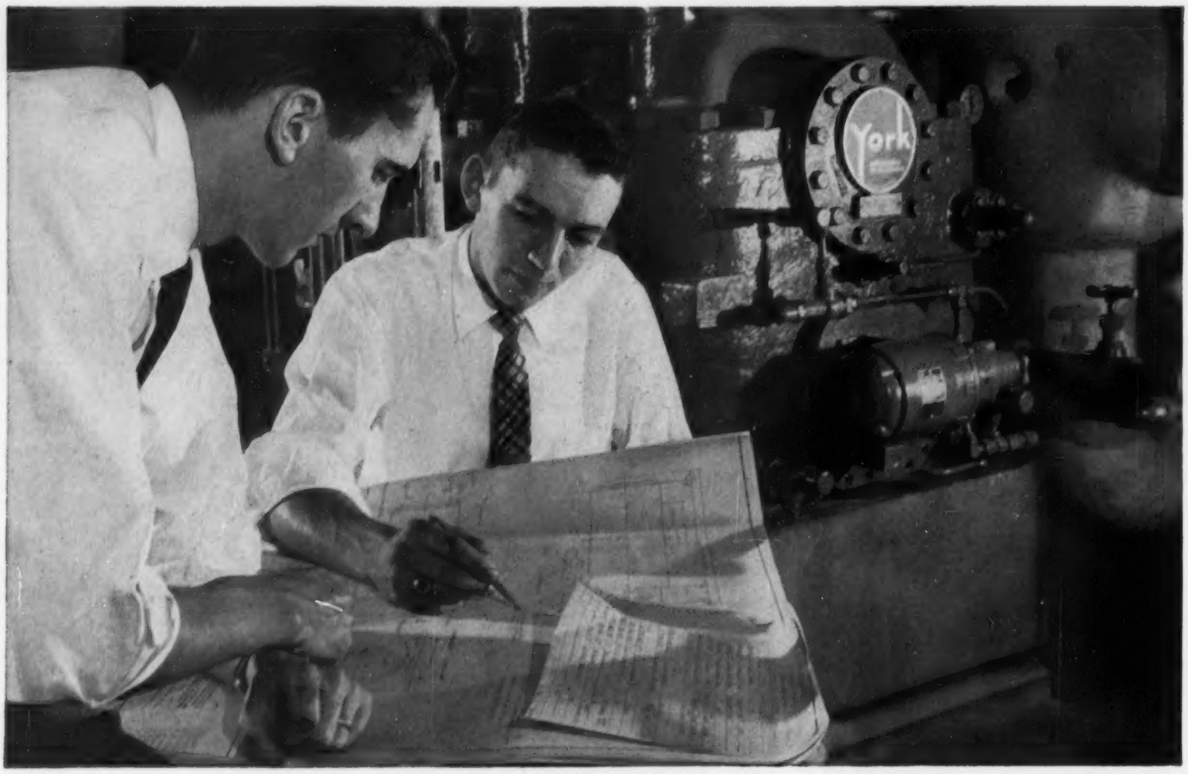
**CORNELL'S E-DAY PAVILION**

Here at Cornell, on Engineer's Day 1956, a pavilion using the Unistrut Space Frame System was erected on the Quadrangle by students of the College of Architecture. Sponsored by the College and by the Gargoyle Society and designed by students, the pavilion was erected by students in three days and dismantled afterwards in one. By leaving the roof structure exposed, the designers took advantage of the elegant geometry of the space frame in defining the exhibition space. A tower, also of Unistrut members assembled into pentahedrons, completed the exhibition structure. The parts, which were donated by the Unistrut Corporation have been returned to the company and may be reused for another structure, temporary or permanent.

The significance of the Unistrut system is not that it will pioneer a new and great architecture, or that it is an important milestone in structural theory, but simply that it is a fine example of a means by which average communities can afford good, practical architecture in their schools and other public buildings and by which individuals can attain beauty, simplicity and economy in their homes.



**Photos of the erection of the Engineer's Day Pavilion at Cornell by the members of the College of Architecture.**

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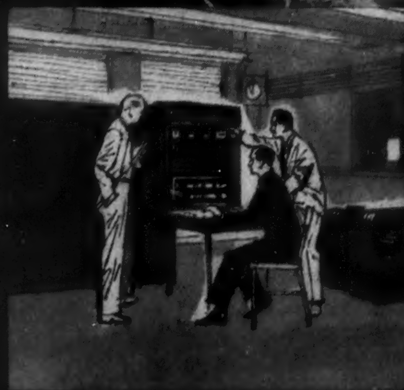
# ELECTRONIC GIANT SQUEEZES THE ERROR OUT OF WEATHER FORECASTING



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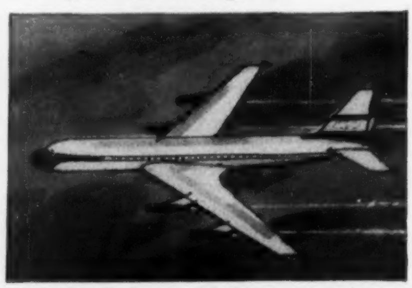
Making 16,000 additions or 2,000 multiplications every second, the computer forecasts the daily weather with an accuracy that would have required some 64,000 mathematicians thirty years ago. In addition, it encourages meteorologists to tackle problems that once discouraged them because of the staggering mathematics involved.

## Forecasting YOUR future

Weather prediction is one more example of how IBM computers—in business, science, government and education—are revolutionizing our way of doing things. These mathematical marvels are destined to play an increasingly important part in the *careers* of engineering graduates. Digital computers rank in importance with nucleonics and automation in our new industrial revolution. If you are working toward an E.E. or an M.E. degree, or, if you are majoring in physics or mathematics, you'll find that IBM, as a leader in the electronic computer field, offers you the opportunities you need for a successful engineering career.

**For further information** about opportunities at IBM, see your Placement Director or write to R. A. Whitehorne, Mgr. of Engineering Recruitment, Dept. 3302, International Business Machines Corporation, 590 Madison Avenue, New York 22, N. Y.



"Flight-testing" without flight: At aircraft plants, IBM computers *pre-test* planes, simulate actual flight conditions mathematically, eliminate hazardous testing.

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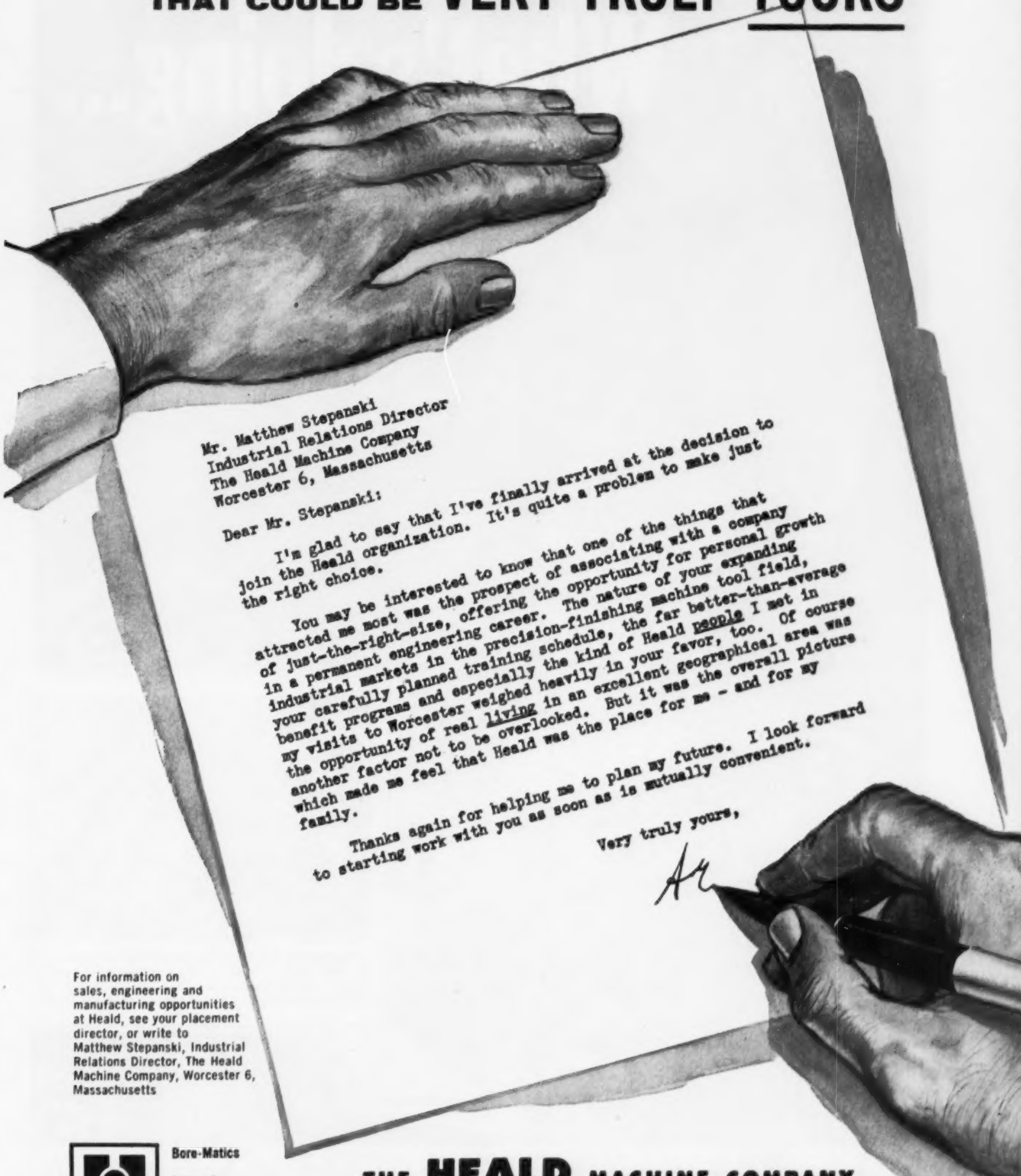


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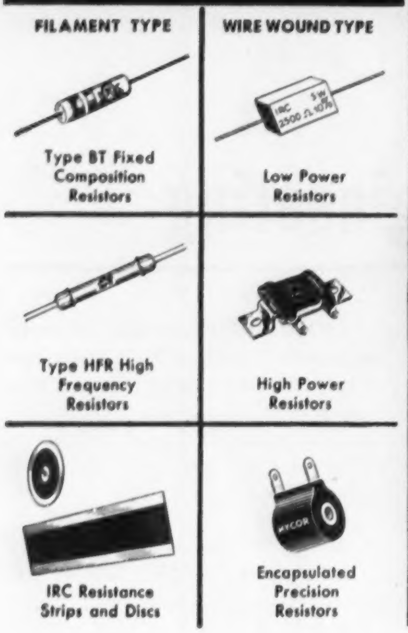


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# Book Reviews . . .

*Unit Operations of Chemical Engineering* by Warren L. McCabe, Polytechnic Institute of Brooklyn, and Julian C. Smith, Cornell University. McGraw-Hill Book Company, New York, 1956, 945 pages, $10.50.

This latest addition to the growing number of books on unit operations is, in a sense, another revision of that old standard, Badger and McCabe, which is so familiar to a generation of chemical engineers. A work by Badger and Banchero on unit operations was published a little over a year ago. But McCabe and Smith gives a much broader coverage and considerably more attention to the fundamental principles involved than any previous text on the subject.

Three sizeable chapters explain in considerable detail the basic concepts of fluid mechanics, flow of heat, and mass transfer. These sections are essential in the comprehension of all unit operations.

An introductory chapter explains the physical laws, mass and energy relationships, and useful mathematical methods. There are other chapters devoted to transportation of fluids, size reduction, handling of solids, mixing, mechanical separations, evaporation, gas absorption, distillation, leaching and extraction, crystallization, air-water contact operations, and drying.

In addition to the excellent theoretical treatment given, considerable space is devoted to the machinery and equipment of each unit operation. Each chapter contains many solved example problems as well as unsolved problems. An extensive list of pertinent references is included at the end of each chapter and includes many recent advances in each operation. The style and organization is quite clear and informative.

Former students of Professor Smith at Cornell will recognize a considerable amount of material as having been taught in his courses on Chemical Equipment and Advanced Heat Transfer.

It is difficult to find an omission of any consequence in this monumental work. Next to Perry's *Chemical Engineers' Handbook*, this is undoubtedly the most complete

*(Continued on page 46)*

## *Book Reviews . . .*

*(Continued from page 45)*

work in its field and may easily become the standard text and reference on unit operations for some years to come.—JST

*Applied Metallurgy for Engineers* by Malcolm S. Burton, Cornell University. McGraw-Hill Book Company, New York, 1956, 450 pages, $7.50.

*Applied Metallurgy for Engineers* is directed toward students and practising engineers who have had little or no metallurgical background. In writing this book, Professor Burton's purpose was twofold: to develop the background of the science of metals and to apply the principles developed to some of the more common operations of metals engineering.

In order to provide a broad foundation for use in discussing the engineering operations, the book begins with a review of the nature of metals, to include a discussion of atoms, crystals, and solidification. The next section of the book, which is closely associated with the above, is devoted to metallurgical examination and evaluation of metallic materials. Topics considered are optical microscopy, X-ray methods, and mechanical testing.

There follows a detailed discussion of the principles and practice of the heat treatment of metals and alloys. Both ferrous and non-ferrous materials are discussed. The subject is considered from a fundamental viewpoint in contrast to the empirical approach used in many elementary texts. Moreover, the practical application of principles to engineering operations are clearly illustrated. Some of the more important topics considered are phase diagrams, heat transfer, hardenability, quenching and tempering.

The remainder of the text, about two-thirds, is devoted to foundry, metalworking, welding, brazing, soldering, and powder metallurgy. Each topic begins with a discussion of theory and principle and then proceeds to the application of this background to the metallurgical operation concerned.

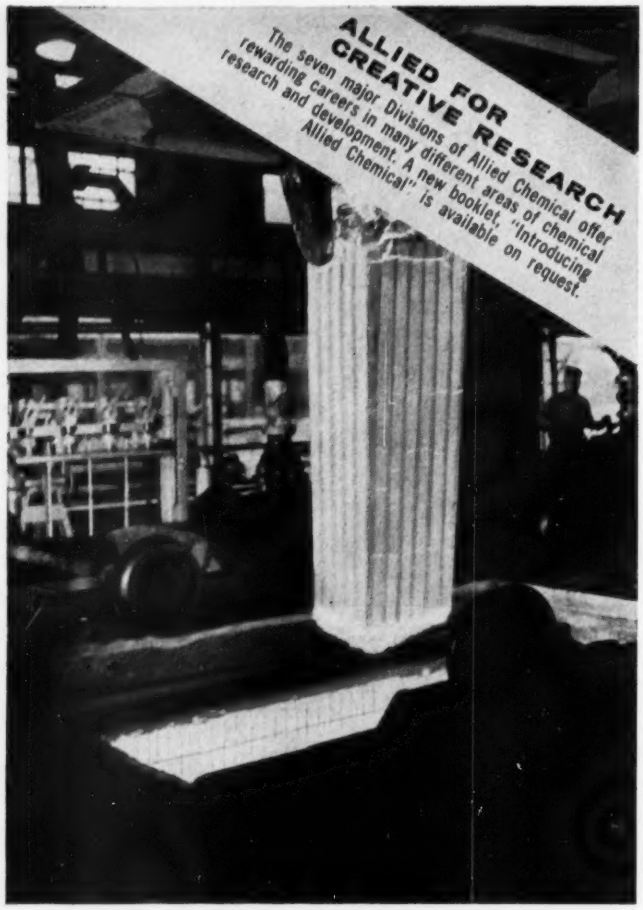
Professor Burton's text is a welcome addition to those available in this field as some of the areas discussed have not previously been adequately covered. It is particularly outstanding in its organization, which permits a logical and interesting approach, and in its illustrations, which are both clear and attractive.

C. Spencer
Professor of Met.E.

*red hot* **STEEL**

*and*

*cool cool* **COMFORT**

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Faculty Profile . . .

# DR. HANS BETHE

Dr. Hans Bethe, famous theoretical physicist, and Professor of Physics at Cornell.

by
John M. Walsh III, ChemE '59

Dr. Hans Albrecht Bethe has led an amazing life—amazing in the fact that his life has been a series of important achievements many of which would be to other scientists their crowning success. To Dr. Bethe, however, outstanding accomplishment in an undertaking has become so commonplace that he does not consider these achievements at all unusual.

Dr. Bethe was born in Strassburg, Alsace-Lorraine. His father was a professor of physiology and Dr. Bethe descended from a family of scholars and scientists. Dr. Bethe inherited an interest in science from his father but soon demonstrated a flair for mathematics and physics rather than physiology. At the age of ten, when many students were learning multiplication and division tables, Dr. Bethe was amusing himself by calculating long tables of powers of numbers. He soon discovered, however, his main interest in numbers lay in using these concepts to calculate solutions which could be verified by tests and observations. Sometime thereafter Dr. Bethe got a book on calculus, a subject he found fascinating. He was amazed at the great wealth of information (properties of curves, the course of chemical reactions) which could be derived by such a simple means. The particular calculus text Dr. Bethe used was written by a physical chemist. This too had a bearing on his later leanings toward the science of physics.

At the age of eighteen Dr. Bethe enrolled in the University of Frankfort. He studied chemistry, physics, and mathematics and soon found, as before, his real interest lay in calculations which had significance in chemistry and physics, not in abstract mathematics nor in experimental physics or chemistry. His work began to deal more and more with theoretical physics.

At the age of twenty-two Dr. Bethe received his Ph. D. from the University of Munich after only four years of college. He maintains that this was not a great accomplishment in continental Europe for students frequently got a Ph.D. before the age of twenty-two. The reason for this is that in continental Europe a high school education was about equivalent to two years of college in America.

From the time of his graduation in 1928 until 1933, Dr. Bethe was an instructor in theoretical physics at the Universities of Frankfort, Stuttgart, Munich, and Tubingen. From 1933 unil 1935 he was lecturer at Manchester and Bristol, England. In 1935 Dr. Bethe came to Cornell as Assistant Professor. Two years later he was named Professor.

In 1938 Dr. Bethe developed one of the most important theories in the field of energy production in the stars when he postulated that the carbon-nitrogen cycle was instrumental in the production of energy in the sun. Professor George Gamow records in his book, *The Birth and Death of the Sun,* the story of this discovery:

"'It should not be so difficult after all to find the reaction which would just fit our old Sun,' thought Dr. Hans Bethe, returning home by train to Cornell from the Washington Conference on Theoretical Physics of 1938, at which he first learned about the importance of nuclear reactions for the production of solar energy; 'I must surely be able to figure it out before dinner!' And taking out a piece of paper, he began to cover it with rows of formulas and numerals, no doubt to the great surprise of his fellow-passengers. One nuclear reaction after another he discarded from the list of possible candidates for the solar life supply; and as the Sun, all unaware of the trouble it was causing, began to sink slowly under the horizon, the problem was still unsolved. But Hans Bethe is not the man to miss a meal simply because of some difficulties with the Sun and, redoubling his efforts, he had the correct answer at the very moment when the passing dining car steward announced the first call to dinner."

This story is not exactly true for, as Dr. Bethe allowed, Prof. Gamow is quite a joker and meant the story to be amusing as well as to contain an element of truth. The story started as told, when Dr. Bethe went to the comference in Washington and learned of the problem of stellar energy. Because the problem held great interest for him, Dr. Bethe came back to Ithaca and started working on it. At this time Dr. Bethe and Professor Charles Critchfield both felt that the reaction was the direct combination of two protons. There were some flaws in the hypothesis since the observed energy output of the Sun was greater than the theoretically calculated output of the reaction. Beside this, theoretically calculated and observed outputs of the very brilliant giant stars could not be reconciled. Nevertheless, Dr. Bethe set out to prove this was the desired reaction by eliminating all other possible reactions.

Dr. Bethe started eliminating reactions by working through the periodic table, calculating energies produced and comparing these values with observed energies.

At the end of six weeks, having progressed from hydrogen through boron, and having eliminated each in turn, Dr. Bethe began work on his famed carbon cycle. When his calculations were complete, he realized that this reaction, not the proton-proton reaction, was the one he was looking for. This reaction not only agreed with the Sun's observed output but was the probable reaction for the brilliant stars as well. The identification of this reaction was a large step toward a knowledge of the mechanisms of energy production in the stars.

In 1943 Dr. Bethe's work at Cornell was interrupted when he went to work in Los Alamos Atomic Scientific Laboratory as Director of the Theoretical Physics Division for three years. He was awarded the Presidential Medal of Merit in 1946 for his work in this capacity.

Most of Dr. Bethe's recent years have been spent studying the properties of mesons, particles of 200 to 300 electron masses, which are believed to be the glue holding the atomic nucleus together. Dr. Bethe has written a book on the known properties of mesons, *Mesons and Fields.* He has spent a great deal of time in an effort to analyze the properties of these particles and to understand how they behave. He is also interested in what these particles have to do with the interacions beween particles in the nucleus.

At present Dr. Bethe is working on the structure of atomic nuclei. In the past, collisions between two nucleons—protons, neutrons, or other parts of the nucleus—in the free state were observed. From these collisions much was learned about the way nuclear forces bind neutrons and protons together to form a nucleus. Now Dr. Bethe wants to return to the starting point and find how the nuclear forces studied by nucleon collisions give the nuclei their observed properties.

The oldest problem of nuclear physics, the saturation effect, will be one of the first to be studied.

The saturation effect is the property whereby nuclei act like bulk mass. A nucleus which contains twice as many particles (neutrons and protons) as another occupies twice as much space as the other. This property is not encountered in the structure of the outer parts of the atom outside the nucleus. For example, a sodium atom has only eleven electrons while uranium has ninety-two. Yet the sodium atom is larger than uranium. This is why physicists were surprised by the saturation effect in nuclei. Dr. Bethe will try to explain this in terms of the properties of nuclear forces. Another property to be explained will be the periodic behavior of nuclei. Nuclei, like chemical elements, have a periodic table. The properties of the nuclei vary periodically and some nuclei may be saturated as the inert element argon is saturated with electrons) while other nuclei seem to have "incomplete outer shells." For nine years it has been known that nuclei have periodic properties but only in the last two years has it been thought possible to reconcile nuclear forces and the apparent shell structure of nuclei. This reconciliation will be given much consideration. Other scientists are also working on these projects.

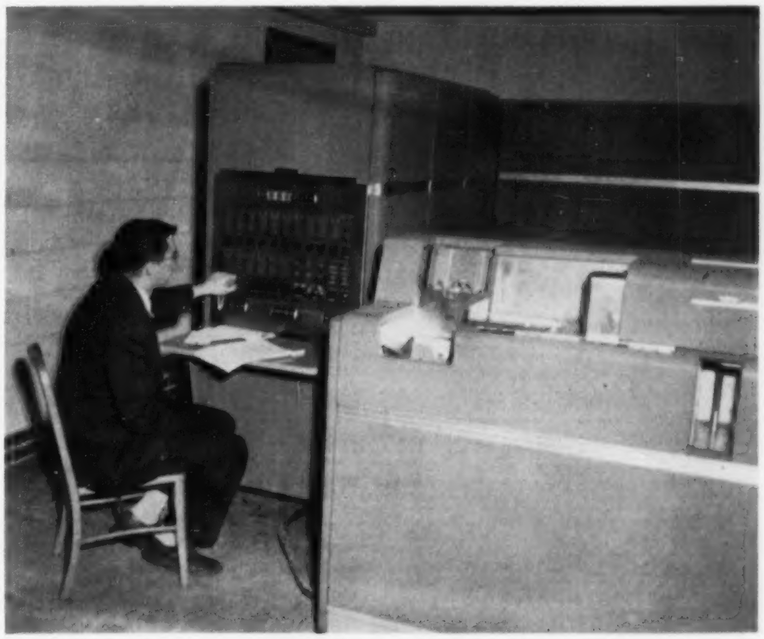
In addition to his work on nuclei, Dr. Bethe teaches several graduate courses in theoretical physics. Alternating with two other physicists, Dr. Bethe teaches theoretical mechanics, electricity, and magnetism; statistical mechanics; quantum mechanics; and some special courses on theory of nuclei and theory of phenomena at very high energies (100 million electron volts to several billion electron volts). Dr. Bethe especially enjoys being able to teach his students the latest developments in these fields and being able to work with students at seminars where vital problems under consideration and recent discoveries are discussed.

# COLLEGE NEWS

### COMPUTING CENTER USES IBM 650

With the start of the new academic year, the Cornell Computing Center will achieve full academic stature in recognition of its contribution to the instructional program at Cornell. The Center was originated in January of 1954 and had its first headquarters in Rand Hall. As of last July, however, it moved to Phillips Hall, the School of Electrical Engineering.

Facilities of the Center revolve around an IBM type 650 magnetic drum data processing machine, that is rented for approximately $1500 per month. The Center serves the University in three major areas: in general instruction, in problem solving for student and faculty research projects, and in computation of general business problems by agencies within and without the University.



**Cornell's IBM Computer used to solve complicated research problems as well as general business problems.**

The 650 was first publicized on campus during the month of October when a series of lectures were presented by Mr. Richard C. Lesser, the director of the Center. Now, a new, recently-initiated program encourages instructors to bring their classes to the Center and share a lecture hour there.

The computer itself is a general purpose fixed decimal machine of three units. It can, however, use an interpretive floating decimal system and in this way it is better suited for relatively short scientific and engineering calculations. The console, power and read-punch units that make up the 650 run on 230 volts line input. Their combined power consumption of 12,000 watts pours approximately 50,000 BTU per hour into the room housing the machine. Consequently, a ten ton air conditioner is required to keep the Center at normal room temperature.

The 650 uses IBM cards in both its input and output sections. Problems are first analyzed, then written in machine language, coded and finally punched into cards. These instruction-bearing cards and the actual numbers or data involved in the problems are then interspersed in the read-punch unit and the 650 begins to calculate.

Instead of the bank of magnetic tapes used in larger machines like the IBM 701 or the Remington Rand Univac, the 650 makes use of a magnetic drum as memory. This drum stores all the information necessary to process a problem. Its maximum capacity is 20,000 digits. The drum is a Cobalt-Nickel plated cylinder about 4 inches in diameter and 16 inches in length which revolves at a speed of 12,500 revolutions per minute. Information is stored on the surface of the drum in the form of magnetic spots; each digit being identified by a recognizable pattern. Since the spots are magnetized permanently, there is no danger of loss of information through accidental power failure.

The 650 is internally self checking, i.e., it automatically identifies errors in both reading and punching. When cards have been incorrectly punched, or when the basic operational codes of the machine are violated by the required mathematical operations, the machine comes to an automatic halt. Each stage may then be checked manually to locate the difficulty.

The Computing Center now employs three full time programmers and two research assistants, in addition to Mr. Lesser. Presently, the staff spends the greater portion of its time solving research problems for university faculty members with a somewhat smaller emphasis on teaching the use of the equipment.

*(Continued on page 65)*

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**Walter L. Hardy**

*"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates, and former students and to establish closer relationship between the college and the alumni."*

## SOME THOUGHTS FOR FUTURE ENGINEERS

This letter is principally directed to the high school senior who is considering engineering as a profession and especially to those who are thinking of the College of Engineering at Cornell as the first step in that direction.

First let me say, with a slight bit of prejudice, that engineering is the most fascinating and one of the most rewarding of the professions. It can create in the student and practitioner a feeling of pride in almost daily accomplishment through the variety of its tasks, the vigor of its demands and the swiftness of its progress.

But first remember one thing. Engineering, like any profession, is not easy nor a soft road to success. If it were, the rewards would be equally poor in proportion. If you do not have a sincere interest in mathematics and the sciences, don't start your training—you probably will not finish it. Or if you do, you probably will never be happy when your work is a chore and a bore instead of a vital, primary part of your life.

Once your decision is made then resolve to be a *good engineer*. No matter what happens to our economy at some future date, there will always be a place for a *good* engineer, or a *good* doctor or a *good* carpenter. With this resolve, pick a good engineering college for your training. There are many—and Cornell's College of Engineering is one of them. Naturally, we think one of the best.

A good engineering education trains the man to think, to analyze, to draw conclusions and to make recommendations or to take action. It should teach him how to communicate these results to his fellow men both through writing and verbally. The engineer serves in many functions: research, development, sales, management, public relations, teaching. A well educated man must know not only mathematics, physics and chemistry but also psychology, philosophy, human relations and how to write in his native tongue, if he is to succeed. The world in which we live demands it. This well rounded education cannot be acquired in less than five years—and on this basis Cornell's College of Engineering requires these five years.

We can also talk in terms of investment. The additional investment for your fifth year will be repaid many times over in terms of potential earning over the ensuing years.

Further, let me add that a university is more than an assembly of laboratories, lecture rooms and professors. While you are there, it is a way of life unlike any you will ever experience. It provides a source of friendships and associations and a feeling of pride and of belonging far out of proportion to the time expended. Ask the man who has been there. Consider this too, when you choose your College. We think Cornell can give you all you want and need—and then some.

Walter L. Hardy

# ALUMNI ENGINEERS

**Calvin O. English, BS in AdmE '41,** has been named assistant superintendent in charge of Quality Control operations at Bakelite Company's Bound Brook plant.

Mr. English joined the firm in 1945 and has held a series of technical and supervisory positions in both production and Quality Control operations. Immediately before receiving his latest appointment, he was head of the Phenolic Molding Material Department.

During World War II, Mr. English served as a Marine fighter-pilot in the South Pacific. He presently holds the rank of major in the Marine Reserve.

Calvin O. English.

**Thomas Cosgrove, C.E. '09,** superintendent of blast furnaces and coke plants for Republic Steel Corporation steel plants in Canton and Massillon, has retired on pension after more than 45 years in the steel industry.

Born in Braddock, Penn., Cosgrove followed in the tradition of his father, who was a superintendent for Carnegie Steel in Braddock.

During summer vacations from Pittsburgh Academy and Cornell University, from which he received a civil engineering degree, Cosgrove worked in steel plants.

After 10 years' work in engineering capacities at steel operations in the Pittsburgh area, Cosgrove came to Canton in 1919 as a foreman for United Furnace Co., a Republic predecessor.

In 1929 he was named assistant superintendent of the coke plant at the Canton steel plant. He was promoted to superintendent of blast furnaces and coke plants for the Central Alloy District in 1943. In this capacity he supervised the work of approximately 400 employees.

He is a member of the Eastern States Blast Furnace & Coke Oven Association.

**John D. Lewis, BChemE '48,** is a project engineer with Hydrocarbon Research, Inc. His address is 89 Park Place, Watchung, N.J.

**Ward B. Browning, Jr. BS in EE, '44,** has recently been named project engineer with the Armco Steel Corporation. Browning became associated with Armco in 1946 as an engineering draftsman in the General Engineering Division. Prior to this, he had been employed at the Ashland, Ky. works for several summers while he was attending Cornell. He was promoted to electrical engineer in 1947 and senior electrical engineer in 1951.

Ward B. Browning, Jr.

**Robert H. Olsen, Ch.E. '46,** has been appointed ammonia caustic soda supervisor at the Syracuse plant of Solvay Process Division, Allied Chemical & Dye Corp. He joined the company following graduation and has held several supervisory positions prior to his present assignment. Olsen was quite active at Cornell as president of the Glee Club, member of the editorial board of the **Cornell Engineer,** and student instructor in Chemical Engineering. He has carried on with a diversity of interests in Baldwinsville, serving on the Village Board, in the Kiwanis Club, and as a vestryman of the Grace Episcopal Church. He is married and has two sons.

**Charlie Peek** works for Pratt & Whitney Aircraft in East Hartford, Conn. The September issue of The Power Plant, that company's house organ, has a picture of Charlie and the news that he has been promoted to assistant project engineer.

**Cecil W. Armstrong, M.S. in Engr '38,** was named "Outstanding Engineer of the Year" and presented with a citation to that effect by the St. Joseph Valley section of the American Society of Mechanical Engineers at a banquet in his honor in South Bend, Indiana, on April 19th. He is head of the consulting engineering firm Cecil W. Armstrong & Associates with its principal office at Warsaw, Indiana. He taught in Sibley Hall 1936-40.

Mr. **Leon R. Chrzan, BChem '41, ChemE, '42,** has recently been appointed to the staff of the Tonawanda, New York, Laboratories of Linde Air Products Company, a Division of Union Carbide and Carbon Corporation. His present assignment is with the Research Group. Mr. Chrzan received a Bachelor's degree in Chemistry from Cornell University in 1941 and in 1942 he received a Bachelor's degree in Chemical Engineering. Prior to beginning with Linde, he was associated with the Detroit Research Laboratories of the Ethyl Corporation as Assistant Supervisor of

the Chemical Engineering section. Mr. Chrzan was very active in the Detroit section of the American Institute of Chemical Engineers.

**Gardner Ertman '50**, hit the jackpot in an international small homes contest. He was grand prize winner and a category first prize, for $1500 in the Lisle, Ill., contest. His dream home is a two-bedroom house with roof-to-ground picture windows, built-in flower beds, and a covered porch, to build for $17,500. Gardner is a draftsman in Cambridge, Mass. According to a Chicago newspaper clipping, he spent two years in the Air Force, toured Europe studying architecture under a Cornell fellowship grant and won a $2500 Europe prize in an international house competition sponsored by a Canadian firm, and has won several other smaller prizes.

"He lives in a carriage house with his wife, Mary Jane, a former Chicago society reporter," the clipping states. "The home is converted from a stable. A stall serves as the kitchen. Ertman worked for an architects' firm in Belleville, Ill., before moving to Cambridge." Gard won out in the recent competition among 612 entries from 37 States and several foreign countries. Two of the homes he designed will be built by the prize donor, which means more profit for Gardner, who was described by the newspaper as 27 and "the balding young New Englander . . ."

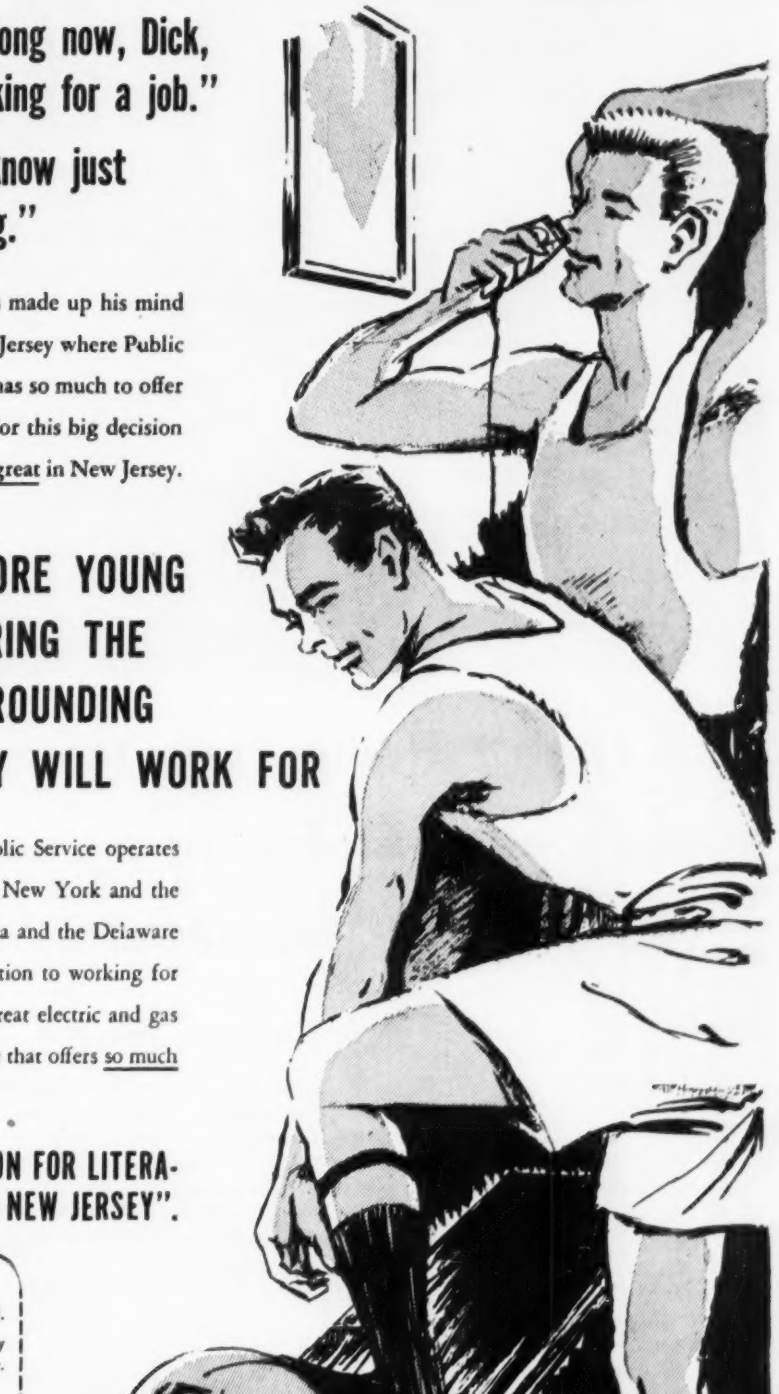
**Joseph C. Pursglove, Jr., C.E. '30**, is president of Mountaineer Carbon Co., which was formed recently by Standard Oil Co. of Ohio and Pittsburgh Consolidation Coal Co. The new company will operate a carbon calcining plant at Cresap, W.Va., about twenty-five miles south of Wheeling. Since 1947, Pursglove has been vice-president in charge of research and development of Pittsburgh Consolidation Coal Co. His address is 520 Irwin Drive, Edgeworth, Sewickley, Pa.

**A. Griffin** (Griff) **Ashcroft** resigned as vice-president of research and engineering of Alexander Smith, Inc. at the time of its merger into Mohasco Industries, and is now staff associate of Arthur D. Little, Inc., well-known Cambridge, Mass., research and development consultants. Griff represents them in their New York City branch office.

# LOCKER ROOM "SCUTTLE BUTT"

**"Well, it won't be long now, Dick, before we start looking for a job."**

**"Right, Joe, and I know just which way I'm going."**



We happen to know that Dick has made up his mind to start operation job hunt in New Jersey where Public Service Electric and Gas Company has so much to offer graduates. One of the big reasons for this big decision in his life is that he knows living is great in New Jersey.

## YES, MORE AND MORE YOUNG MEN ARE CONSIDERING THE ENVIRONMENT SURROUNDING THE COMPANY THEY WILL WORK FOR

New Jersey offers so much, and Public Service operates in a compact area of the state, with New York and the Hudson on the north and Philadelphia and the Delaware on the south. So give close consideration to working for Public Service, one of the country's great electric and gas utility companies, and living in a state that offers so much to you now and in the future.

**FILL OUT THIS HANDY COUPON FOR LITERATURE ON "YOU, A JOB, AND NEW JERSEY".**

Public Service Electric and Gas Company,
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Please send me literature on New Jersey and job opportunities with Public Service.

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A-39-57

**PUBLIC SERVICE ELECTRIC & GAS CO., NEWARK 1, N. J.**

## COLLEGE NEWS

*(Continued from page 57)*

### MODEL AIRCRAFT FOR RESEARCH

Around the turn of the century, when men first built flying machines, they also made test models to study flight characteristics in advance of full-scale flight. The first models, crude counterparts of today's highly engineered models, were mounted on pivots at the end of a whirling arm. A few years later they were catapulted over a smooth floor in still air. Distances and direction were indicated by marks left by small bags of lampblack carried in the model.

It was only after these beginnings that the idea was born of holding the model stationary and blowing air past it in the first crude wind tunnels. It must be remembered that the model not only came before the tunnel, but was in fact the very reason for the tunnel's existence. With an accurate, carefully designed aircraft model, the wind tunnel is a useful test facility where design characteristics can be verified before the full-scale aircraft is built. The model enables the designer to make design improvements in a relatively inexpensive manner.

In keeping pace with and, in fact, contributing to advances in this field, the Cornell Aeronautical Laboratory variable density tunnel has become one of the world's busiest and most versatile.

CAL's 8 x 8-foot variable density transonic wind tunnel is scheduled for around-the-clock operation. Such operation stems naturally from the need of the airplane or guided missile designer to have test data as rapidly as he can get them. As a result, a great deal of pressure is placed on the model-design and model-making teams to perform their tasks rapidly. Tunnel operations are accelerated by use of removable cart test sections which permit the advance installation of each model in a separate cart outside the tunnel.

*(Continued on page 66)*

Before a model is ready for installation on one of the carts, however, it must be created by the model maker (Figure 1). Each man is encouraged to combine his experience with his inventive imagination, and thus to improve the quality and reduce the time span on numerous jobs. Machining common materials by conventional practices represents a large percentage of the time the model maker spends on any job. But those models of complicated design, which produce more test data faster, demand that novel fabrication techniques be used. Functional design, strength, quality, and low cost are important attributes of the models built and tested. Five types of models are commonly fabricated in the Laboratory's model shop.

The model designer requires certain essential information as a basis for each new model. Information supplied by the customer and the wind-tunnel aerodynamics section is considered a specification for the new model. This specification usually includes: basic model dimensions; required test configuration; maximum angle range of pitch, yaw, and roll; angular settings of movable surfaces; number of load and moment components to be measured; desired number, size, and location of pressure orifices; and extent of inspection required.

While meeting the aerodynamic specifications, the design must also meet other basic model requirements. These include: strength and rigidity, with all structural members designed to have a safety factor of five; simplification of design for ease of fabrication; incorporation of any feature which will reduce tunnel shutdown time required for model configuration change.

One of the many design features the Laboratory has developed, and has incorporated in the model of the Fiat G-91 airplane, is a small, flexure-type hinge fitting which facilitates hinge moment measurement of extremely thin control surfaces. A strain gage beam is an integral part of this fitting. Small angle adapter blocks permit angular deflection of the control surface. This precisely machined plate eliminates the need for hinge pins and bearings.

The Avro C-105 aircraft model put to good use another valuable design detail—a unique method of tail attachment. A longitudinal square beam is machined as an integral part of the vertical fin. This strain gage beam is located at the base or root section, with its aft end fixed to the fuselage. A narrow slot, cut between the root of the fin and the beam, extends halfway forward from the trailing edge. When a side load is applied to the vertical surface it causes the beam to twist, thus permitting measurement of normal force.

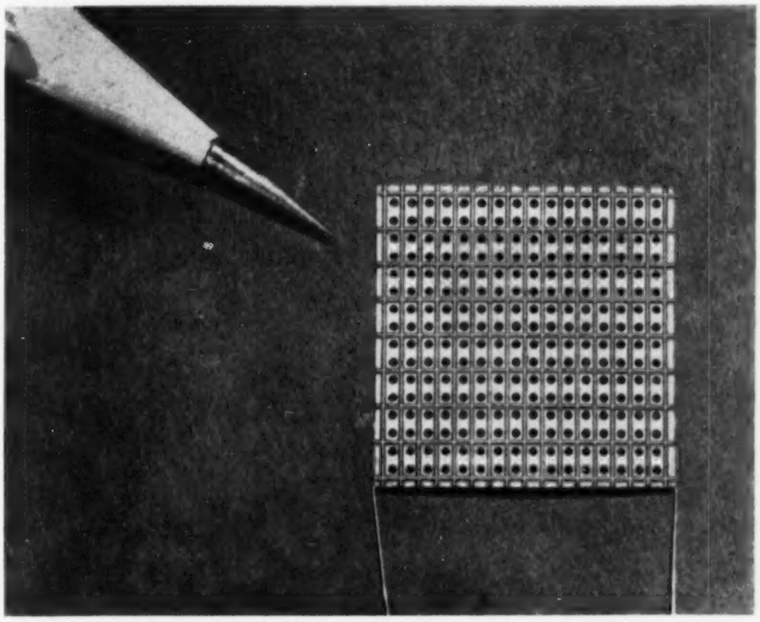
*(Continued on page 73)*

# TECHNIBRIEFS

## NEW ELECTRONIC MEMORY

A new memory device that will enable electronic computers to store more than a million bits of information in a space little larger than a shoe box and to recall any or all of the items in a few millionths of a second was announced by the Radio Corporation of America.

The new memory, consisting basically of thin, printed plates of special magnetic material perforated with small holes, was developed by a research group under the direction of Dr. Jan A. Rajchman. Announcing the new unit, Dr. Irving Wolff stated that it "opens the way to major advances in efficiency in electronic computers and data processing systems.



This tiny perforated plate is the high speed memory for a newly developed electronic computer.

"A key point in the operation of all electronic computers is the information storage system in which various elements of a computing problem are stored electronically and recalled instantly as they are needed. . . . The new apertured plate now provides a means for handling millions of bits of information, and at the same time offering far greater compactness and operating simplicity than could be achieved with any earlier system. Moreover, the new device lends itsself to extremely simple molding production techniques.

"This development should permit the design and construction of larger and more versatile electronic computers and data processing systems, and it will at the same time provide a compact and economical type of memory for relatively small computing equipment."

Explaining the new device, Dr. Rajchman pointed out that its operating principles are based on the fact that computer language consists only of "O" and "1," used in various combinations to represent any words, numbers or symbols.

"Since any desired information can be formulated in terms of O and 1, it is possible to employ a storage or memory system in which each of the memory elements can be switched electrically to represent one or the other of these two values," Dr. Rajchman explained.

"The new aperture plate memory stores this information in the form of magnetic fields. One of the two values is represented by a flow of magnetism, or magnetic flux, in one direction around a hole in the plate, while the other value is represented by a magnetic flux in the opposite direction."

The small plates used in the new system are made of a special ferromagnetic material, a ceramic-like substance that can be molded in any desired size or shape and hardened by heating. The experimental units are less than an inch square and contain 256 holes, permitting the storage of 256 bits of information in each plate.

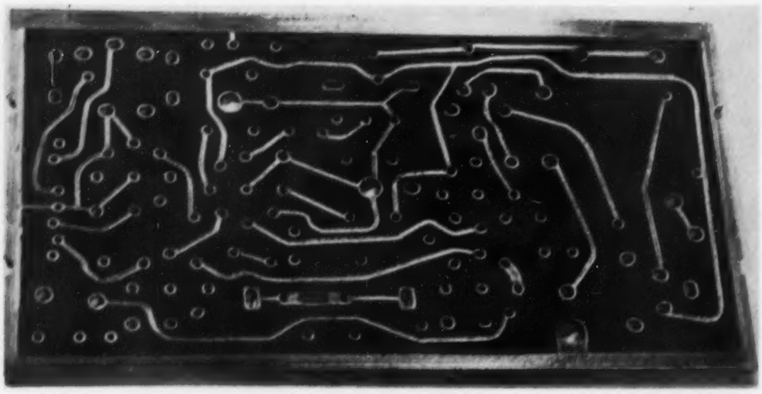
With the plate system, the plates are insulators and the holes can be joined by conductors using the highly efficient printed circuit technique.

The development of these aperture plates has now reached a stage which opens possibilities of memories of very large capacities—millions of bits. Because this arrangement requires much less driving power than previous systems, it promises also to reduce and simplify the associated electronic circuits. Furthermore, it makes possible very compact memories of relatively small capacity.

Dr. Rajchman displayed a compact memory plate unit consisting of ten plate assemblies and a novel switch also made from the plates. This developmental unit, measuring only 2 cubic inches, has a storage capacity of 2560 bits of information.

## NEW PRINTED CIRCUIT PANELS

A revolutionary new type of printed circuit panel, moulded of



Printed circuit panel.

a variety of resins that are superior in electrical and physical characteristics, will eliminate the use of expensive piercing dies and punch presses. The panel, which sells for two-thirds the cost of an average etched panel, has been developed by Die Form Circuits, Inc., of Cicero, Illinois.

This unique panel is provided with circuitry on one or both sides, as desired, and is the first to be of moulded material offered to the electronics industry.

These panels require but two weeks engineering to bring to production, whereas construction of piercing dies requires for presently offered varieties 10 to 14 weeks.

The panel is custom made to any design or size. Its design characteristics provide indestructible attachment of components by automatic soldering. Adhesion of circuitry approaches molecular attraction without the use of adhesives. No wet flux application is required prior to soldering, thereby eliminating the necessity of cleaning after assembly.

Paper laminate commonly shrinks after heating prior to piercing. Because the holes do not align, the automatic process jams. This is now avoided by relatively large hourglass shaped holes. The conductors and hole linings are entirely of copper with electroplated solder applied to the entire circuitry to prevent copper oxidation which also facilitates soldering.

Rosin flux is baked onto the panel, being applied to points to be soldered, and thus eliminating the use of wet flux and the additional operation of washing off the residue after soldering. The hour glass shaped copper lined holes of the panel after soldering are completely filled by a solder nugget securely imbedding component terminals. Accordingly, no component terminals need be crimped either for holding or to affect soldering.

The elimination of crimping will allow manual insertion of parts by operators at the assembly machine and therefore permit complete assembly in any combination of manual and automatic insertion.

Circuitry configuration and holes are moulded into the panel, thus depressed below the outer surface secure from physical damage and free from circuit shorts due to component enclosures resting on the panel surface.

An electrical grade phenol resin is used whose minimum characteristics of power factor, dialectric constant and water absorption are far superior to the most expensive grades of paper laminate.

This unique method of fabricating a printed circuit provides a completely cured panel that will not soften under the high temperatures necessary in soldering to assure complete alloying to the circuitry. The panel will be approved for continuous operating temperatures in a finished instrument of 150 degrees Centigrade, 45 degrees above Underwriter approval for paper laminate.

Physical stability of the completely cured panel prevents lifting of circuitry. This occurs with paper laminates due to vapor pressure induced by volatiles and unpolymerized resins of the laminates.

Low moisture absorption and homogeneous texture of the surface prevent retention of acid salts, whereas etching or plating of paper laminate risks absorption in plies of wood fiber exposed on all edges and holes. Material in sheet form only is usable in current printed circuit panels. However, any resin that can be transfer moulded may be used in these new panels.

## SMALLER SIZE DIESEL ENGINES

The greatest possibility for reducing the size and weight of diesel engines for marine and railroad uses is offered by a highly supercharged two-cycle engine compounded with a turbine driving an axial flow compressor. The cylinder layout which offers the greatest potentiality for such development is the "opposed piston" design.

An interesting solution of the problem, the Napier "Deltic" engine, designed by D. Napier & Son, Ltd., has opposed piston cylinders arranged in a triangle with crank shafts at the three corners. This arrangement overcomes most of the technical objections to the opposed piston layout. Furthermore, the space in the center of the delta may be used for an axial flow compressor, making the complete compound engine compact. This engine weighs about 2½ lb. per BHP for an output of 550 BHP.

Apart from space and weight savings, which are important in ships and locomotives, a reduction in overall maintenance costs was reported to be derived from the use of small engines. This is obtainable by adopting the "repair by replacement system" which permits saving in skilled engineering service and avoidance of loss of serviceability time with its economic penalties. Even a complete change of engines is possible within a few hours.

Extensive engineering data was presented in support of the contentions that the development of the high-speed diesel is justified on both technical and economic grounds. They covered practical speed limits, three types of engines, air supply, fuel efficiency, utilization of heat and distribution of temperatures, and power output per unit volume of cylinder.

## AN UP-TO-EARTH VIEW OF THE FUTURE

The Martin launching vehicle of the first man-made Earth satellite will be the opening gun of a new and endless age of exploration into space.

There are many exciting new opportunities at Martin.

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**MARTIN**
BALTIMORE

## COLLEGE NEWS

*(Continued from page 66)*

Although the Model Shop is well equipped with power tools, handwork is still needed, indeed is desirable, to produce a given model in the shortest time. Model construction begins with preparation of model scale layout plates and templates. The templates are cut and notched to prevent shifting. Then the outer edges of the template are ground square and parallel as a reference. This facilitates alignment and assembly of the model.

Reinforced wood and Fiberglas are common materials for the wings and fuselage of subsonic models, such as the Fairchild M-230 and the Martin Skymaster aircraft models. The fuselage outer shape is built over a steel skeleton. This inner framework consists of a box or tubular beam to which a tapered wing beam is attached. The fuselage beam houses the balance and provides a means of tail attachment. Aileron and flap brackets are secured to the wing beam. Wood blocks or molded plastic sections are resin-bonded and machine-screwed to the beam structure. This assembly is then reduced to the desired contour by fitting templates and fairing between sections.

Nacelles and fuselage ducts are conveniently molded around removable cores. Fiberglas cloth impregnated with Kish, Rezolin, or Renite resin is satisfactory for this method of construction.

Metal wings are machined from either aluminum or steel. Plate or forgings hammered to an oversize shape are used. If strength requirements allow the use of aluminum, the machining operation is practically the same as for steel; however, cutting speeds can be increased to a degree where the aluminum wing will cost only 75% as much as a similar steel wing.

To construct an average high-speed wind tunnel model, a combination of mechanics is used—template makers, machinists, and model bench men. Actual model construction is always started well before completion of the design. This reduces the over-all time span and allows the shop people to contribute to the design. Detail parts are usually completed in an eight-week period. Assembly of classified models within a restricted area, as was the case with the Bell X-1 model, requires two additional weeks.

Quality of workmanship is of prime importance. Dimensional accuracy and surface smoothness are imperative. Experience in building models, ranging in size from 6" span supersonic models to flutter models of 96" span, has prompted originating a tolerance chart which specifies allowable error, based on size of the model. This chart shows separate cross section variation for template, airfoil, body, and over-all assembly. It allows only a plus for template error and only a minus deviation for the template to model.

Model making is a dynamic skill and new techniques are continually being advanced. In the not too distant future, wind tunnel models will probably have simulated jet propulsion. Model testing in the transonic range will incorporate design features to permit the model to deform when subjected to aerodynamic forces.

In designing, building, and testing these new wind tunnel models, best results will continue to be accomplished by a mutual understanding of available methods, advantages, and limitations.

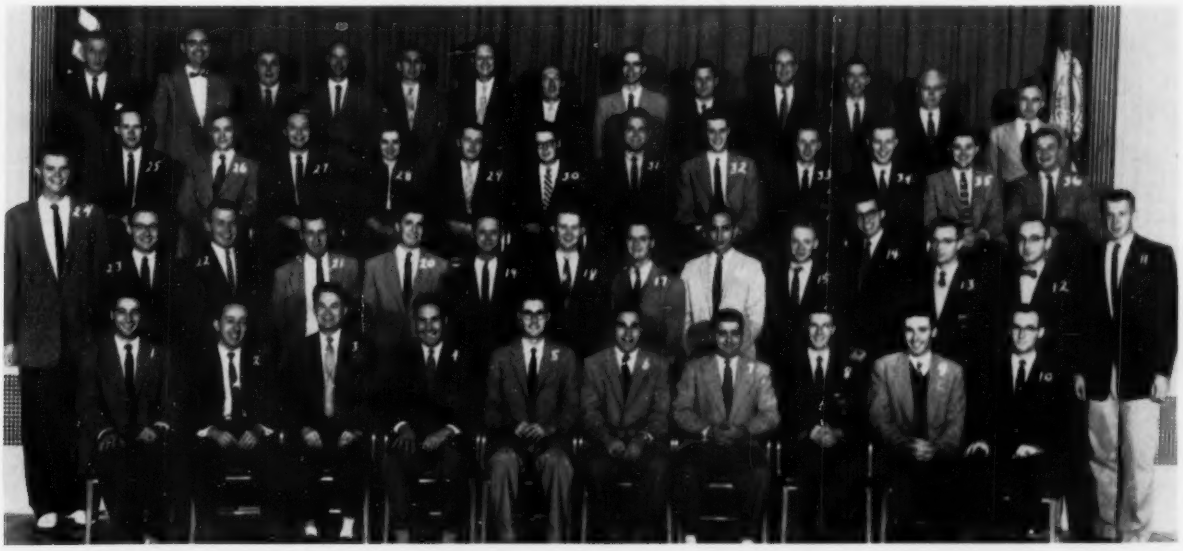


### CAL STUDIES RAIN

One who walks through a gentle spring rain seldom considers that raindrops can be small destructive "bullets" when they strike a high speed airplane. These bullet-like raindrops can erode paint coatings, plastic parts, and even magnesium or aluminum leading edges to such an extent that surfaces appear to have been sandblasted. The struc-

*(Continued on page 78)*

# GRADUATING CHEMICAL AND METALLURGICAL ENGINEERING CLASS



Chemical and Metallurgical Engineers—Class of '57.

1. Martin H. Wohl; 2. Morton H. Friedman; 3. Ray A. Young; 4. Lewis N. Stone; 5. Alan W. Pense; 6. William B. Eisen; 7. John F. Lombard; 8. George L. Mueller; 9. Herbert Senz; 10. Don H. Phillips; 11. Raymond D. Zelek; 12. Erlend R. Lowrey; 13. Daniel P. Rathman; 14. Robert D. Bradford, Jr.; 15. Roger K. Fisher; 16. Arthur F. Gast; 17. John H. Hanna; 18. Philip C. Kimball; 19. D. Nathan Parks; 20. Donald L. Corey; 21. John B. Devries; 22. Roger L. Baldwin; 23. Gary Kirby; 24. Alfred Hahn; 25. Robert O. Dunn; 26. John E. Lind, Jr.; 27. David S. Lermond; 28. Lavonne O. Tarleton; 29. Edmund M. Mackert; 30. Robert D. Bruce; 31. Richard P. Scheifele; 32. Joseph J. Fitzsimmons; 33. George S. Gulick; 34. Edgar W. Averill, Jr.; 35. W. R. Burt, Jr.; 36. Howard S. Wheeler.

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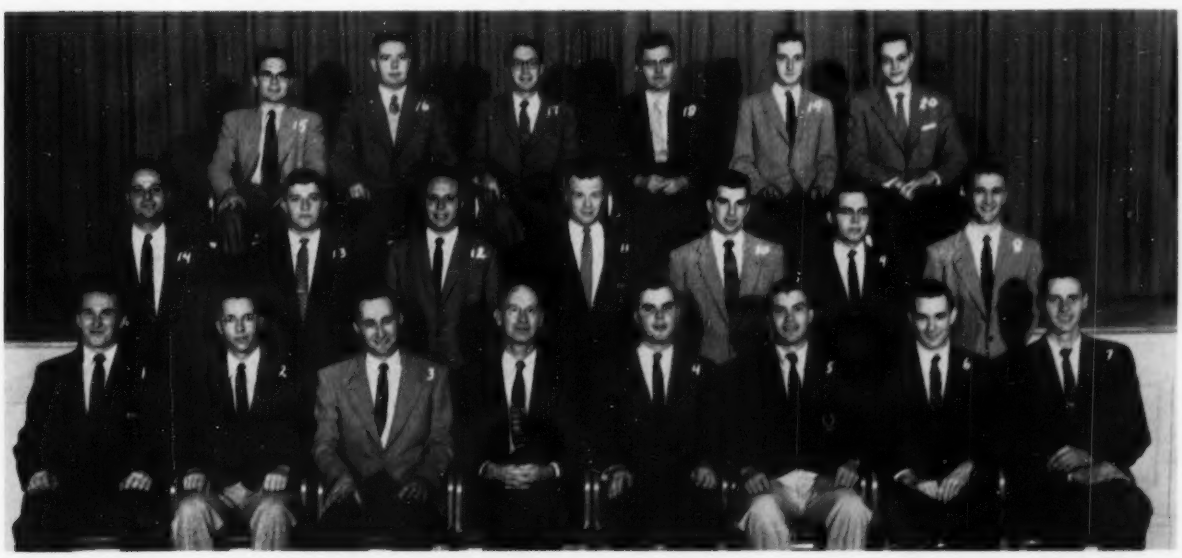
# GRADUATING ENGINEERING PHYSICS CLASS



Engineering Physics—Class of '57.

1. John F. Ahearne; 2. David H. Coward; 3. David Abraham; 4. James A. Larrimore; 5. Don P. Moon; 6. Robert M. Taylor; 7. Milton A. Chace; 8. Richard R. Levin; 9. Joel Max; 10. Robert A. Kaplan; 11. Francis J. Wiegand, Jr.; 12. Matthew C. Starr; 13. Robert H. Kantor; 14. Paul Gorenstein; 15. Richard Dolen; 16. Peter Woods; 17. David E. Lew; 18. David Galbraith; 19. Robert T. Braden; 20. Steven Georgiev.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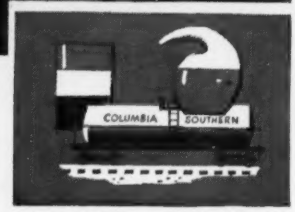
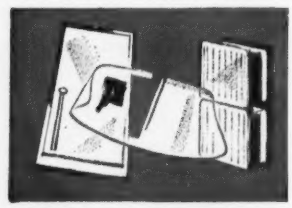
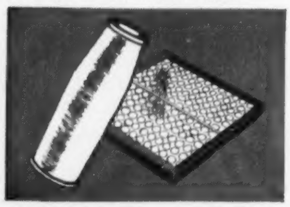
# PPG stands for leadership and expansion in many fields




Columbia-Southern Chemical Corporation, a subsidiary of PPG, is a leading producer of industrial chemicals.



PPG produces large quantities of glass for automotive, home building, commercial and industrial uses.



PPG's fiber glass and PPG plastics are used for many applications.

Pittsburgh Plate Glass Company—the best-known name in glass—is also a leader in paints, brushes, plastics, fiber glass and chemicals.

PPG's paints and brushes, for example, are sold in volume from coast-to-coast through nearly 14,000 dealers and through 230 company branches. It has 17 plants producing paints and brushes.

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## COLLEGE NEWS

*(Continued from page 73)*

tural integrity of the airplane may be affected after several hours of flight through rain. This problem is of special interest to military aircraft engaged in all-weather flying. Cornell Aeronautical Laboratory, Inc., of Buffalo, N.Y., has studied the rain erosion problem under Air Force contract since 1948. In an article appearing in the recent issue of the Laboratory's *Research Trends* magazine, engineer Norman Wahl described CAL'S erosion research program.

Erosion by water drop impact has become an increasingly important research problem in the postwar era of high speed aircraft. Although most materials will not erode when an airplane flies below 400 miles per hour, plastics used in the noses of bombers and in radomes are important exceptions. They will begin to erode through completely in one or two minutes.

Late in 1946, military personnel began to report the wearing away of plastic radome housings and paint coatings from leading edges of aircraft after short flights through rain-swept areas. New all-weather fighter interceptor aircraft experienced erosion of aluminum or magnesium leading edges after one or two minutes of flight at 650 to 700 miles per hour through rain. A program of research on the rain erosion of aircraft materials, prepared by CAL and presented to the Armed Services for support, was accepted by Wright Air Development Center in 1948, and CAL's Materials Department was given prime responsibility for the work.

Methods of simulating flight through rain were studied and the work eventually led to the design and fabrication of a test facility known as the "whirling arm." Airfoil-shaped specimens of plastic, metal, glass, or ceramic, are fastened to each end of a five-foot propeller which revolves horizontally at controlled speeds through simulated rain. Raindrops fall from calibrated nozzles twenty-five feet above the test specimens. The blade runs at from 300 to 750 miles per hour. As a safety measure, the test equipment is placed in a concrete-reinforced cell ten feet below ground.

In early research, CAL studied droplet size, velocity of specimens, temperature of water and ambient air, angle of impact, and specimen shape, to determine the effect of these variables of the rate of erosion. Tests were conducted at two rainfall concentrations: one inch per hour to simulate a moderate rainfall and three inches per hour to simulate a torrential rain. In the simulated three-inch rainfall, drops

*(Continued on page 80)*

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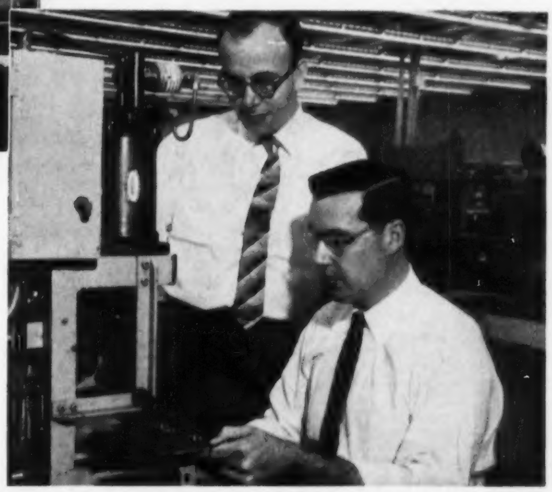
# Meet Bill Hancock

## *Western Electric development engineer*

**Bill Hancock** is a graduate of Pennsylvania State University where he majored in industrial engineering. Bill joined Western Electric as a planning engineer in November, 1951, at the Kearny Works in New Jersey. Later, he was assigned to the new Merrimack Valley Works in North Andover, Massachusetts, as a development engineer. Here Bill is shown leaving his attractive New England home for his office while his wife, Barbara, and their daughter, Blair, watch.

**Bill's present assignment** at Western Electric: the development of methods and machinery for assembling one of today's most promising electronic developments – electronic "packages" involving printed wiring. At a product review conference Bill (standing) discusses his ideas on printed wiring assemblies with fellow engineers.



**Bill and his supervisor,** John Souter, test a machine they developed to insert components of different shapes and sizes into printed wiring boards. The small electronic packages prepared by this machine are being used in a new transistorized carrier system for rural telephone lines.

**Sailing** off the north shore of Massachusetts is one of Bill's favorite sports. He also enjoys the golf courses and ski runs within an easy drive from where he lives and works.

**Engineers:** Western Electric offers you a wide variety of interesting, *creative* opportunities. It makes no difference what your field of specialization is. You can fit – now – into our operation as the manufacturing and supply unit of the Bell System . . . or into our defense job. A free booklet –"Your Opportunity at Western Electric"– outlines company operations and specific job opportunities in detail. Send for it. Write to: College Relations Department, Room 1030, Western Electric Company, 195 Broadway, New York 7, N. Y.

**Western Electric**

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## COLLEGE NEWS

*(Continued from page 78)*

ranged from 2.5 to 2.7 millimeters.[1]

Investigations revealed that the larger the raindrops, the greater the erosion, due to the greater kinetic energy of the large drops; also, that drop size determines the critical velocity at which erosion of a specimen begins to occur. Even with drop sizes as large as five millimeters, damaging erosion does not occur below velocities of 250 miles per hour.

Each type of material has a threshold velocity below which erosion is not initiated even after exposure for as long as twenty-four hours. The critical velocity appears to be proportional to tensile strength and hardness of materials; stainless steel and chromium or nickel base metals have the greatest resistance to rain erosion. Elastomers such as neoprene, with its good resilience and tensile strength of more than 200 psi., have the greatest resistance to rain erosion of any non-metallic materials. However, as speed increases from 300 to 750 miles per hour, the amount of erosion on all types of materials increases rapidly.

The first encouraging results in making materials more corrosion-resistant followed studies of resilient, rubber-like coating materials. When a program of developing a new coating started, the average life of a plastic or elastomeric coating was approximately thirty seconds at 500 miles per hour and one-inch per hour of rainfall. After three years of development and evaluation tests, a neoprene coating has been evolved that is capable of withstanding rain erosion for two hours.

Several CAL departments have contributed to rain erosion studies, notably Flight Research, which has conducted erosion tests on an F9F jet aircraft flying at 500 miles per hour. Specimens of various materials were bonded to the leading edge of the wing and exposed to light and heavy rainfall.

[1] Meteorological studies have shown that normal raindrops vary in size from .5 to 5 millimeters.

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GR57-1

HERCULES
CHEMICAL MATERIALS FOR INDUSTRY


# For Blanketing Fire in Chemicals, Gasoline, Oils

These pictures were taken at Robins Air Force Base in Georgia during acceptance tests of a Grinnell ProtectoFoam System. Above, a man slogs through foam to check the spray pattern produced by over 800 nozzles discharging 75,000 gallons of foam per minute.

With a ProtectoFoam system, a vapor tight blanket of foam floats on liquids and clings to solids, extinguishing flames and preventing re-ignition. It is particularly effective against fires in gasoline, oils, and chemicals.

The foam, a harmless mixture of water and a protein base foaming agent, is produced mechanically by special Grinnell nozzles. When the foam compound has been used up or shut off, these nozzles then discharge water in the same manner as standard open sprinklers. Once the fire is out, the water discharge may be used to wash down the building and equipment and clean away the foam.

ProtectoFoam is only one of many Grinnell Fire Protection Systems designed for special hazard application. For further information, write to Grinnell Company, Inc., Providence, Rhode Island.

Foam flows under aircraft to form a complete blanket.

Truck breasts hub-deep foam blanket outside hangar. Foam will dry out and disintegrate to a powder.

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ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL

# STRESS *and* STRAIN...

**Prof.: "What is an engineer?"**

**Student: "A person who passes as an exacting expert on the basis of being able to turn out with prolific fortitude innate strings of incomprehensible formulae calculated with micromatic precision from vague assumptions which are based on debatable figures taken from inconclusive experiments carried out with instruments of problematical accuracy by persons of doubtful reliability and questionable mentality for the avowed purpose of annoying and confounding a hopeless chimerical group of fanatics referred to all too frequently as Engineers."**

• • •

Seven-year-old Michael, who had a reputation as a little terror, had just finished his first summer vacation at his grandparents' farm. Back in the city, one of the neighbors asked him about his holiday and especially about his grandfather.

"Oh, he's great," responded Michael. "We played a swell game every day. Late each afternoon he'd row me out in the middle of Claytor Lake, throw me over the side of the boat and let me swim ashore."

"Claytor Lake?" gasped the neighbor. "That's a big lake. Wasn't that a hard game for such a little fellow as you?"

"I'll say it was," said Michael. "But the hardest part was getting out of the sack."

• • •

**The professor who comes in 15 minutes late is rare; in fact, he is in a class by himself.**

• • •

A judge was examining a prisoner who was accused of stealing a bundle of silverware. "Where did you get it?" he asked the thief.

"From the fraternity house, Your Honor."

"Call up the hotels, Sergeant, and distribute the stuff."

• • •

A woman surprised her husband in a bar, sampled his drink, made a wry face and demanded: "How can you drink such horrible stuff?"

"See!" exclaimed the husband with injured dignity. "And all the time you thought I was having fun."

• • •

**New Parson: "I'm certainly glad to have such a wonderful congregation."**

**Parishioner: "And we're delighted to have you. You have been so informative. Why, we didn't know what sin was before you came."**

• • •

"Faith," declared Mike, " 'tis an unthankful country that this is. Here we Irish have done so much for the United States, and b'jabbers they've named only one state after an Irishman."

His faithful friend Pat raised his red eyebrows. "I didn't know there was such a state, Mike!"

"Sure and have ye niver heard o' that western state O'Regon."

• • •

**Disappointed first-grader after first day in school: "I'm not going back. I can't read or write and they won't let me talk."**

• • •

He: "Whisper those three little words that will make me walk on air."

She: "Go hang yourself."

• • •

**A group of prohibitionists looking for evidence of the advantages of total abstinence were told of an old man 102 years old who had never touched a drop of liquor. So they rushed to his home to get a statement. After propping him up in bed and guiding his feeble hand along the dotted line, they heard a violent disturbance coming from another room—furniture being broken, dishes smashed, and the shuffling of feet.**

**"Good heavens, what's that?" gasped a committeeman.**

**"Oh, whispered the old man as he sank exhaustedly into his pillows, "that's Pa, he's drunk again."**

• • •

Professor: "A fool can ask more questions than a wise man can answer."

Student: "No wonder so many students fail your exams."

• • •

**A man was perched atop a building in Atlanta and it looked like another suicide attempt. A policeman made his way to the building's roof to persuade him not to jump.**

**"Think of your Maw and family," pleaded the cop.**

**"Ain't got any."**

**"Well, think of your girl friend."**

**"I hate women!"**

**"All right," said the policeman desperately. "Think of Robert E. Lee."**

**"Who's he?"**

**"Jump, you damn Yankee!"**

• • •

Judge: "So your name's Joshua, eh? You're not the Joshua that made the sun stand still are you?"

Culprit: "Lor no, Judge. Ah'm de Joshua dat made de moonshine."

• • •

**The difference between a dress-tie and a noose is that one is worn without a collar.**

• • •

The absent-minded professor drove up alongside his house. He glanced into his empty garage and gasped, leaping back into his car, raced to his insurance agent's office, and reported excitedly: "My car's been stolen again!"

• • •

Instructor: "Before we start this final exam, are there any questions?"

C.E.: "What's the name of the course?"